COLLEGE

Chemistry

PBA 11&12

PRACTICAL BASED ASSESSMENT
HSSC (COMPOSITE)

WORKBOOK

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PREFACE

This chemistry practical workbook has been written for HSSC students in accordance with Federal Board recent Practical Based Assessment (PBA) theme and the national curriculum 2022-23. It covers the entire syllabus and, in addition, different approaches to practical has been given as is required by PBA assessment scheme.

The subject matter throughout the book has been written in a simple, precise and comprehensive form.

All the experiments have been discussed and elaborated to such an extent that no further reading is needed on practical aspect of the syllabus. At the end of each practical, practical Based Assessment (PBA) worksheets have been given which will enable students to evaluate their learning and will prepare them for Federal Board PBA examination.

The author will welcome comments and suggestions to improve the standard of this practical workbook.

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PRACTIAL BASED ASSESEMENT (PBA) GUIDELINES

i. The paper will consist of two sections i.e section A and B.

ii. Section A will include Major Practicals. This section will have three questions, each question carrying 6 marks having parts in it, and each question will be performance / calculation/procedures/observations based encompassing a single practical.

iii. Section B will include Minor Practicals. This section will also have three questions, each carrying 4 marks having parts in it. Each question may be based on single or multiple practicals.

iv. The weightage of section A will be 60% i.e 18 marks, while that of section B will be 40 % i.e 12 marks.

v. In Practical Based Assessment (PBA), there will be no marks for practical notebooks and viva voce. However, students may record procedures, observations, apparatus and calculation etc on any type of plain papers/work sheets / practical folders for their future memory of all aspects of practical performance in order to attempt the PBA Examination amicably.

vi. It may be noted that performance of all the prescribed practicals is mandatory in the laboratory during the whole academic session because only those students will be able to attempt the PBA who have performed the practicals in the laboratory as per requirement of each practical.

vii. MCQs will not be included/assessed in the Practical Based Assessment paper.

viii. Questions carrying 0.5 marks will not be included/assessed as single part in any section of the PBA paper.

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General laboratory Safety

General

- Always come prepared into the laboratory for the experiment to be performed.
- Bring your practical note book and lab coat.
- Take great care while pouring concentrated acids like H_2SO_4, HNO_3 or HCl.
- Do not bring inflammable liquids near the flame.
- Never suck concentrated acids i.e. H_2SO_4, HNO_3, HCl and alkalies like NaOH or KOH by pipette. Use rubber suckers instead.
- Always use forceps to pick solid like Na metal form the jar.
- Handle the glassware carefully.
- Do not taste the salt or any chemical in the laboratory.
- Do not bring the reagent bottles from the side shelf to your seat. It creates a great problem for other students and the laboratory staff.
- Do not waste chemical simply by mixing them. Sometimes mixing of chemicals without any purpose could be very dangerous.
- Be careful and vigilant to note the changes during various tests you perform.
- Follow the hazard symbols printed on the chemical bottles. The symbols & their meanings are given below

Hazard Symbols

RADIOACTIVE

FLAMMABLE

OXIDIZER

POISON

HAZARD

CORROSIVE

BIOHAZARD

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Knowledge of First Aid

First aid box must be readily available in the laboratory and should contain the following things

Bandages	Needles	Lint	Gauze	Cotton wool	Adhesive plaster
Thread	Scissors	Safety pin	Spirit or Dettol	Potash alum	Boric acid
Forceps	Castor oil/Olive oil	Picric acid solution/dressing		Ferric chloride solution	
Burnol	1% acetic acid	8% $NaHCO_3$ Solution		Acriflavine	Iodine solution

First aid measures for various laboratory accidents

A Burns

1 Burns due to Flame or Hot Metals

In case of very small burns, the burnt place should be dipped in 8% sodium bicarbonate solution and then zinc oxide ointment and vaseline should be applied. Then cover it with the bandage.

2 Acid Burns

Wash with plenty of cold water and then with 8% sodium bicarbonate solution. Apply acriflavine or picric acid if burns are severe.

3 Alkali Burns

Wash with plenty of cold water and then with 1 % acetic acid solution.

4 Sodium Burns

Remove the pieces of sodium from the skin. Wash the dry place with water and then with 1 % acetic acid and finally cover it with a gauze soaked in olive oil.

5 Bromine Burns

Wash the place with dilute solution of sodium carbonate and then apply burnol.

B Cut and Wounds

If the wound is due to pieces of glass, remove it and then stop the bleeding if necessary either by applying pressure near the place of injury or by applying a piece of cotton soaked in alum solution.

C Eye Accidents

In case of eye accident, the person must be taken to the doctor. However the first aid may be given according to the type of accident.

1 Alkali in the Eye: Wash with excess of cold water and then with 1 % boric acid solution. Then put a few drops of castor oil in the eye.

2 Acid in the Eye: First wash with plenty of water and then with 1 % sodium bicarbonate solution. Finally, put a few drops of castor oil.

3 Glass in the Eye: If a piece of glass goes into eye then remove the glass. Then add a drop of castor oil.

D Poisons

1. If poison has not been swallowed then spit out and wash the mouth with water many times.
2. If an acid has been swallowed, then drink plenty of water and take lime or egg white.
3. If poison is an alkali, then neutralize it by giving lemon or orange fruit to eat.
4. If poison is arsenic or antimony, then give one teaspoon full of mustard oil or castor oil mixed with milk and white of egg and make vomiting.
5. If copper sulphate has been taken, drink plenty of water containing salt and try to vomit.

E Fire

1 Clothes: Blanket should be wrapped firmly around the person and hold it for 1-2 minutes. This time is sufficient to extinguish the flame.

2 Benches: Use sand to extinguish the fire. If a fire happens in the laboratory, then turn off all burners and use fire extinguishers to control incident fires. Use a stream of carbon tetra chloride for small fires.

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SECTION A

60% of Practical Marks

18 Marks (6 x 3 = 18)

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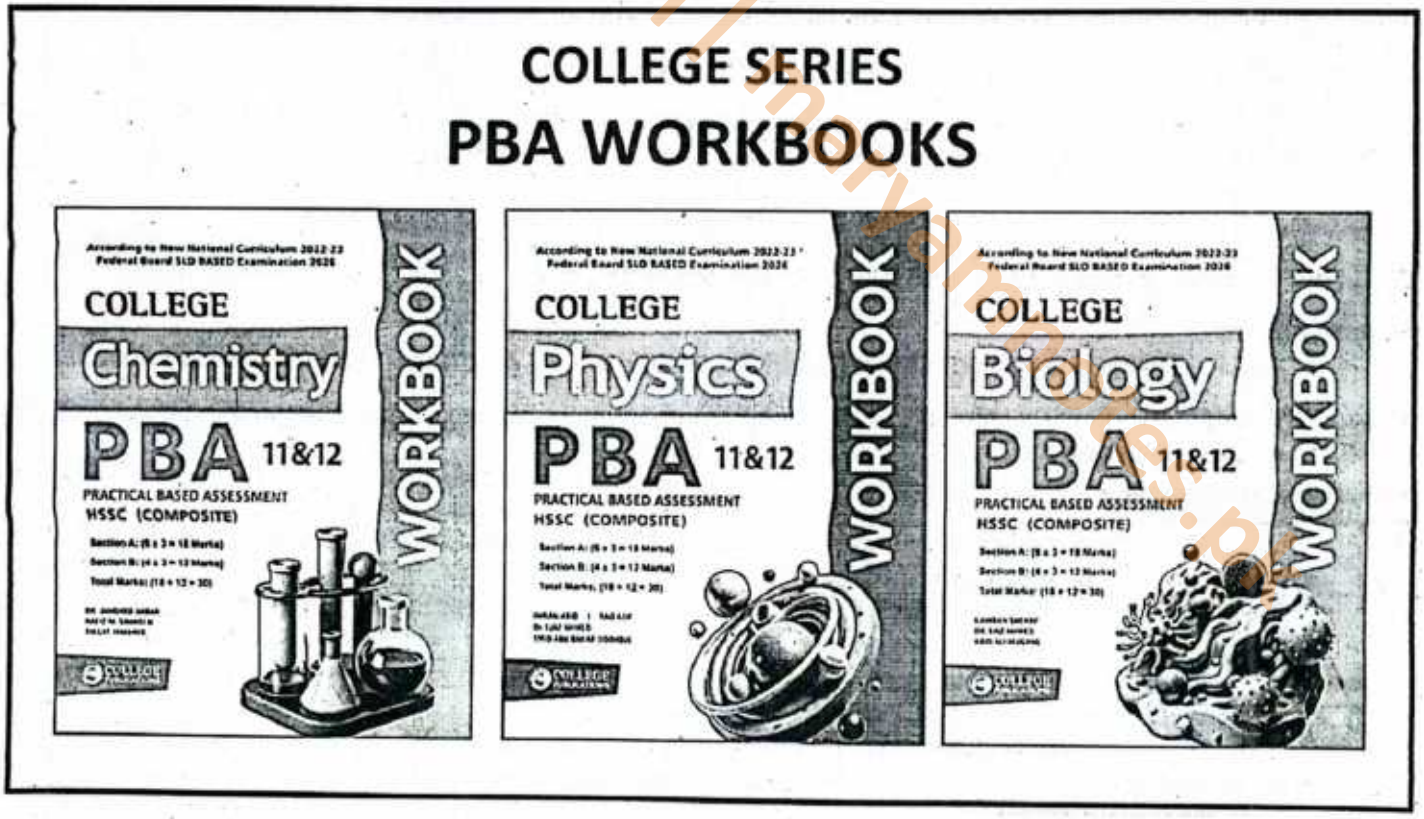

Section-A

Volumetric Analysis: Basic Concepts

Titration: It is the process of determining the exact volume of one solution which reacts completely with a definite volume of another solution.

Titrant: The solution which is taken in the burette in a titration is called titrant.

Titrand or titrate: The solution which is taken in a conical flask in a titraion is called titrand or titrate

Titre: The measured volume of the titrant used to reach the end point of the titration.

Standard solution: A solution whose concentration is known is called a standard solution.

Primary standard: A substance which is 100 percent pure or of known purity and with its help other solutions can be standardized e.g. oxalic acid, sodium carbonate anhydrous.

Secondary standard: A solution whose concentration is not known exactly and must be determined by standardization against a primary standard.
It is less stable or less pure than a primary standard but is used routinely in titrations after standardization. *e.g.*, Hydrochloric acid (HCl), sodium hydroxide (NaOH).

Standardization of a solution:
It means to find the concentration of a solution by titrating it against another standard solution.

End point: It is the point at which the reaction is complete. **Or** It is the point at which indicator changes its colour.

Indicator: It is a chemical substance which changes its colour and shows the completion of a reaction. The choice of indicator depends upon titration. e.g. for strong base (NaOH or KOH) titration with strong/weak acid, phenolphthalein is used.
While for weak base (Na_2CO_3 or $NaHCO_3$) titration with strong acid, methyl orange is used.

Molarity: Number of moles of solute dissolved per litre or per dm^3 of the solution. It is denoted by M.

Molar solution
A solution which contains one mole of a solute dissolved per litre or dm^3 of solution, is called a molar solution.

Volumetric analysis: It is a type of analysis in which amount of a substance is measured in a solution by volume measurement. e.g. acid-base titration.

General instructions

1. Apparatus must be clean or clean it with cleaning mixture of $K_2Cr_2O_7$ + conc. H_2SO_4. Then wash with distilled water.
2. Rinse the burette and pipette with respective solution.
3. Rinse the titration flask with water only.
4. Always use the funnel for adding solution into the burette, remove the funnel from the burette immediately after pouring the solution.
5. There should not be any air bubble in the burette or pipette.
6. While adding solution from the burette into the flask, take care that the solution should not touch the walls of the flask.
7. Read lower meniscus for colourless and upper meniscus for coloured liquids.
8. Take three concordant readings.
9. Always use two drops of indicators
10. Record the result of your titrations into your note book.
11. Wash the apparatus with water after experiment.

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Important Formulas for Volumetric Analysis

1. Calculate molarity using the formula

$$\frac{M_1 V_1}{n_1} = \frac{M_2 V_2}{n_2}$$

2. Calculate mass of substance per dm^3

Mass of substance per dm^3 = Molarity × Molar mass of substance

3. Calculate percentage purity by formula:

$$\text{Percentage purity of substance} = \frac{\text{Mass of substance calculated from volumetric analysis}}{\text{Initial mass of substance dissolved}} \times 100$$

4. Dilution Formula

Given concentration = Required concentration

$M_1 \times V_1 = M_2 \times V_2$

5. Calculate number of water of crystallization

Mass of $(COOH)_2.xH_2O$ per dm^3 = Molarity × Molar mass of $(COOH)_2.xH_2O$
= Molarity × $(90 + 18x)$

Mass of $FeSO_4.xH_2O$ per dm^3 = Molarity × Molar mass of $FeSO_4.xH_2O$
= Molarity × $(152 + 18x)$

Mass of $FeSO_4.(NH_4)_2SO_4.xH_2O$ per dm^3 = Molarity × Molar mass of $FeSO_4.(NH_4)_2SO_4.xH_2O$
= Molarity × $(278 + 18x)$

Amounts to Prepare Solutions of Different Molarities

Substance	Formula	Molar mass ($g\ mol^{-1}$)	0.10 M ($g\ dm^{-3}$)	0.05 M ($g\ dm^{-3}$)	0.025 M ($g\ dm^{-3}$)	0.020 M ($g\ dm^{-3}$)	0.010 M ($g\ dm^{-3}$)
Sodium hydroxide	NaOH	40.00	4.00	2.00	1.00	0.80	0.40
Ferrous sulfate heptahydrate	$FeSO_4 \cdot 7H_2O$	278.00	27.80	13.90	6.95	5.56	2.78
Mohr's salt (ammonium ferrous sulfate hexahydrate)	$(NH_4)_2SO_4.Fe(SO_4)_2 \cdot 6H_2O$	392.00	39.20	19.60	9.80	7.84	3.92
Potassium permanganate	$KMnO_4$	158.00	15.80	7.90	3.95	3.16	1.58
Sodium carbonate (anhydrous)	Na_2CO_3	106.00	10.60	5.30	2.65	2.12	1.06
Oxalic acid dihydrate	$H_2C_2O_4 \cdot 2H_2O$	126.00	12.60	6.30	3.15	2.52	1.26
Sodium hydrogen carbonate	$NaHCO_3$	84.00	8.40	4.20	2.10	1.68	0.84

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SLO: C-11-G-24: Use the correct number of Significant Figures for calculated quantities

1. What are Significant Figures?

- Significant figures (s.f.) show how precisely a measurement is known.
- They include all certain digits and one estimated digit.

2. Importance in Chemistry

- Every measured value (mass, volume, concentration) has limited accuracy.
- In titrations, keeping correct significant figures ensures reliable and consistent results.

3. Reading a Burette

- The smallest division on a burette = 0.1 cm^3 (**e.g.** 25.1, 25.2, 25.3).
- The meniscus often lies between two marks, so we estimate one extra digit. **e.g.** If meniscus is between 25.1 and 25.2 then the reading is 25.15 cm^3. This last digit ("5") is estimated. but significant.
- It is better to record readings to two decimal places, e.g. 25.20 cm^3, 24.85 cm^3. However, reading with one decimal place is also given.

4. Rules for Counting Significant Figures

Rule	Examples	Explanation
1. All non-zero digits are significant.	25.15 cm^3	All digits count **4 s.f.**
2. Zeros between non-zero digits are significant.	102.05 g	All digits count **5 s.f.**
3. Leading zeros are not significant.	0.0250 M	Only 2 and 5 and right 0 are significant **3 s.f.**
4. Trailing zeros after a decimal are significant.	25.00 cm^3	Shows precision to two decimal places **4 s.f.**
5. Trailing zeros without a decimal may not be significant.	1500 cm^3 **2 s.f.** 1.500×10^3 **4 s.f.**	Use scientific notation to show precision.

5. Rules for Calculations

Operation	Rule	Example
Multiplication / Division	Keep same number of significant figures **s.f.** as the least precise value.	2.43 (3 s.f.) × 1.2 (2 s.f.) = 2.9 **2 s.f.** ***(not 2.916)***
Addition / Subtraction	Keep the same number of decimal places **d.p.** as the least precise value.	25.30 (4 d.p.) + 0.4 (1 d.p.) = 25.7 **1 d.p.** ***(not 25.70)***

6. Titration: Significant Figures Guide

Step / Quantity	Example	Type	Significant figures (s.f.) Consideration	Notes
Molarity calculated from titration	0.025 M	Measured	Limits s.f.	Limits s.f. (use least s.f.)
Molarity given in titration	0.05 M (Nominal or approximate value)	Nominal / Defined	Do not limit s.f. unless full precision stated.	Treated as exact for calculation.
Volume measured	500 cm^3 (volumetric flask / pipette)	Measured	Limits s.f.	Use realistic instrument precision e.g. "3 s.f." for 500 cm^3 volumetric flask, not textbook "1 s.f."
Stoichiometric coefficient	$H_2SO_4 + Na_2CO_3 \rightarrow$ 1:1	Exact	Infinite s.f.	Do not limit final answer
Number of moles in ratio	2 moles	Exact	Infinite s.f.	Counting atoms or molecules, exact
Molar mass from atomic masses	NaOH = 23+1+16=40	Exact	Infinite s.f.	Treat sum of integers as exact
Multiplication / Division	M × V or M × molar mass	Measured	Limit s.f. by least precise measured value	Ignore exact numbers in this step
Addition / Subtraction	Volume differences, titration excess	Measured	Limit by least precise decimal place	

Key Rule

- *Exact numbers (from definitions, counting, or stoichiometry) never limit significant figures.*
- *Only measured or rounded numbers limit significant figures.*

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ACID-BASE TITRATIONS

01 EXPERIMENT

Determine the exact molarity of the given solution of H_2SO_4 and the volume of this acid required to Prepare 500 ml of 0.02 M Acid by Volumetric Method

Apparatus used:

Burette, pipette, funnel, conical flask, beakers, iron stand.

Chemicals used:

Methyl orange, 0.05 M Na_2CO_3, Distilled water, H_2SO_4 solution.

Chemical Equation:

$$Na_2CO_3 + H_2SO_4 \rightarrow Na_2SO_4 + H_2O + CO_2$$

Standard Solution:

0.05 M Na_2CO_3

Mole Ratio from balanced equation:

Na_2CO_3	:	H_2SO_4
1	:	1

Indicator used:

Methyl orange

End Point:

Orange red

NOTE:

- Burette/Pipette readings up to one decimal place **1 d.p.** and three significant figures **3 s.f.**
- Molarity of standard solution is ***defined with nominal value*** of 0.05M. So, it is treated as exact and does not limit s.f.

Procedure:

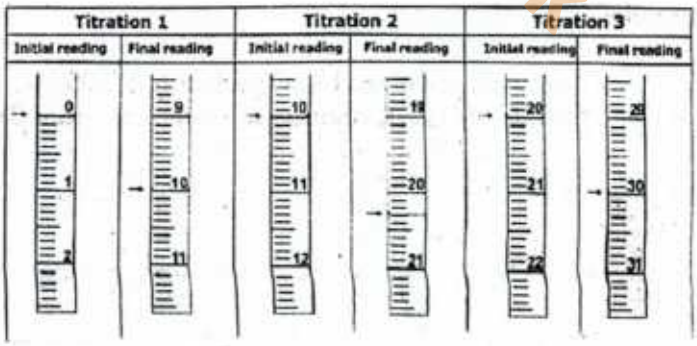
- Fill the burette with H_2SO_4 solution
- Pipette out 10.0 cm^3 Na_2CO_3 solution in a titration flask
- Add 2-3 drops of methyl orange as an indicator
- Titrate Na_2CO_3 solution against H_2SO_4 solution till the end point is reached.

Instructions:

Repeat the titration as many time as you think necessary to obtain accurate results.
Make certain that the recorded results show the accuracy of your practical work.

Observation Table:

Titration number	1	2	3
Final Reading (cm^3)	10.0	20.3	30.0
First Reading (cm^3)	0.0	10.0	20.0
Volume of H_2SO_4 used (cm^3)	10.0	10.3	10.0
Best titration result (✓)	✓		✓



From best titration result,
the average volume of H_2SO_4 used = 10.0 cm^3 **3 s.f.**

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Calculations:

(a) Data for given titration

M_1 = Molarity of H_2SO_4 = ?
M_2 = Molarity of Na_2CO_3 = 0.05 M (defined/nominal value)
V_1 = Volume of H_2SO_4 solution used = 10.0 cm^3
V_2 = Volume of Na_2CO_3 solution taken = 10.0 cm^3
n_1 = Number of moles of H_2SO_4 in balanced equation = 1
n_2 = Number of moles of Na_2CO_3 in balanced equation = 1

(b) Calculation of molarity using the formula

The molarity of the H_2SO_4 solution under test is determined with the help of the following equation:

$$\underset{}{\overset{H_2SO_4}{\frac{M_1 V_1}{n_1}}} = \underset{}{\overset{Na_2CO_3}{\frac{M_2 V_2}{n_2}}}$$

$$M_1 = \frac{M_2 V_2}{n_2} \times \frac{n_1}{V_1}$$

$$M_1 = \frac{0.05 \times 10.0}{1} \times \frac{1}{10.0}$$

$$M_1 = 0.05\ M$$

s.f. similar as given nominal value for Na_2CO_3

(c) By using dilution formula prepare 500 cm^3 (mL) of 0.02 M H_2SO_4 solution

Given concentration in "b" = Required concentration

$$M_1V_1 = M_2V_2$$

$$0.05 \times V_1 = 0.02 \times 500$$

$$V_1 = \frac{0.02 \times 500}{0.05}$$

$$V_1 = 200\ cm^3$$

(d) Brief explanation to make 0.02M H_2SO_4 solution

Measure 200 cm^3 of 0.05 M H_2SO_4 solution using a measuring cylinder. Transfer it into a 500 cm^3 volumetric flask, then add distilled water up to the mark and mix thoroughly.

Result:

The molarity of given H_2SO_4 solution is 0.05 M.
The 0.02 M H_2SO_4 solution was prepared from 0.05 M H_2SO_4 solution.

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VIVA VOCE

1. Which indicator is used for titration of a weak base with strong acid?

Ans: methyl orange

2. What is the color of methyl orange in acidic and basic media?

Ans: Acidic medium: orange red Basic medium: yellow

3. What is the purpose of using methyl orange?

Ans: Methyl orange is an indicator used in titration of a strong acid with a weak base. It is red in acidic medium and yellow in basic medium. So, when the acid-base reaction is completed in titration, it changes its color which indicates the endpoint.

4. How will you prepare 0.1 M Na_2CO_3 solution?

Ans: Mass of Na_2CO_3 = m = ?

Molar mass of Na_2CO_3 = M = $23\times2 + 12 + 16\times3 = 106\ g\ mol^{-1}$

Volume of solution = V = $1\ dm^3$

Molarity = 0.1 M

So, $\text{Molarity} = \frac{m}{M}\times\frac{1}{V}$

or $m = \text{Molarity}\times M\times V = 0.1\times106\times1 = 10.6g$

Thus, 10.6 g of Na_2CO_3 are taken in a $1\ dm^3$ flask and the volume of solution is made up to the mark (i.e. $1\ dm^3$) with distilled water.

5. Calculate the molarity of a solution containing 12.25 g of H_2SO_4 in 250 cm^3 of solution.

Ans: Mass of H_2SO_4 = m = 12.25 g

Molar mass of H_2SO_4 = M = $1\times2 + 32 + 16\times4 = 98\ g/mol$

Volume of solution = V = $250\ cm^3 = \frac{250}{1000} = 0.25\ dm^3$

Molarity = ?

so $\text{Molarity} = \frac{m}{M}\times\frac{1}{V} = \frac{12.25}{98}\times\frac{1}{0.25} = 0.5\ M$

6. What are primary and secondary standards for volumetric analysis?

Ans: *Primary Standard:*

A substance that is pure, stable, non-hygroscopic, has a high molar mass, and can be weighed accurately to prepare a standard solution of known concentration directly.

Examples: Sodium carbonate (Na_2CO_3), oxalic acid ($H_2C_2O_4.2H_2O$), Mohr's salt ($FeSO_4.(NH_4)_2SO_4.6H_2O$).

Secondary Standard:

A substance whose solution cannot be prepared directly with accurate concentration because it may be unstable, volatile, or hygroscopic. Its concentration must be determined by titration against a primary standard. Examples: Hydrochloric acid (HCl), sulfuric acid (H_2SO_4), sodium hydroxide (NaOH).

7. Why is Na_2CO_3 used as a primary standard?

Ans: Because it is stable, pure, non-hygroscopic, and its solution does not decompose easily. Hence, it can be used to prepare a standard solution of known concentration accurately.

8. What are concordant readings?

Ans: *Concordant readings are two or more titration readings that agree closely with each other, usually differing by not more than 0.10 cm^3, indicating precise and consistent titration results.*

Example: Let the burette readings are 24.6 cm^3, 24.5 cm^3, and 24.7 cm^3. Since these differ by not more than 0.1 cm^3, so these are concordant readings.

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PRACTICAL BASED ASSESSMENT (PBA) TEST-1 Marks 06

Q. 25.0 cm^3 sample of Na_2CO_3 solution was titrated with 0.0500 M H_2SO_4 solution from the burette. *The titration* required 25.0 cm^3 of H_2SO_4 to reach the end point.

(a) Write a balanced chemical equation for the reaction between H_2SO_4 and Na_2CO_3 **[1]**

(b) Calculate the molarity of the given Na_2CO_3 solution. **[2]**

(c) Determine the amount of Na_2CO_3 in 100 cm^3 of solution using molarity in (b). (Na=23, C=12, O=16) **[1+1]**

(d) Name a suitable indicator for this titration and state the colour change at the end point. **[1]**

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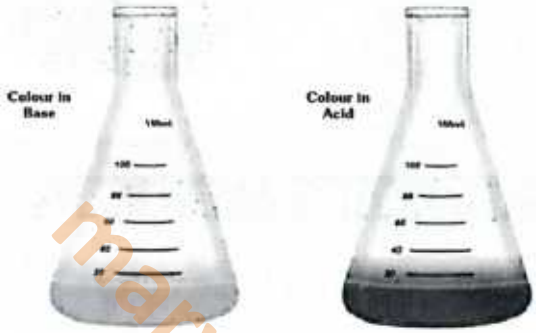
VOLUMETRIC ANALYSIS

ACID BASE TITRATIONS



Before end point | End Point (orange red)

METHYL ORANGE

(Uses for Weak Base Titration)

Weak Bases = Na_2CO_3, $NaHCO_3$, K_2CO_3, $KHCO_3$

INDICATOR	COLOUR IN ACID	COLOUR IN Base
Methyl Orange	Orange red	Yellow

PHENOLPHTHELEIN

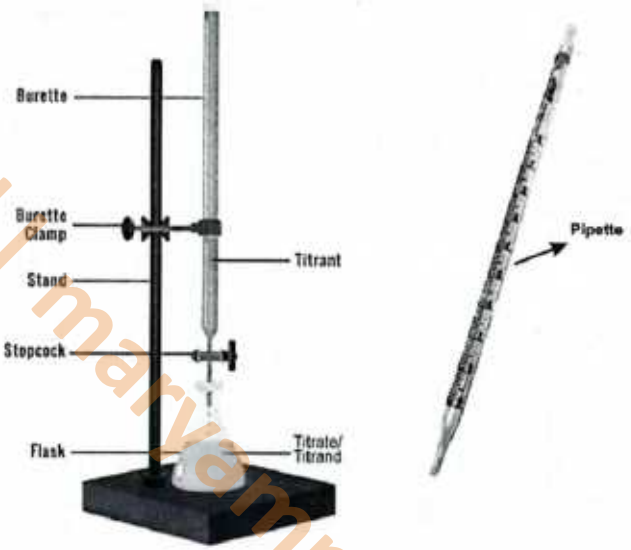
Uses for Strong Base Titrations

Strong Bases = NaOH, KOH

INDICATOR	COLOUR IN ACID	COLOUR IN Base
Phenolpthalein	Colourless	Pink

Before end point | End Point (light pink or just colourless)

APPARATUS FOR TITRATION



REDOX TITRATIONS ($KMnO_4$ Titrations)

Before end point | End Point (light pink)

IODINE TITRATIONS

Add Starch Indicator at this stage (Lemon Yellow Colour) | After addition of starch indicator (Dark Blue Colour) | End Point (colourless)

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SALT ANALYSIS

COLOURS OF SALTS

Cu^{2+} (Blue)

Fe^{2+} (Light Green)

Fe^{3+} (Yellowish)

Cr^{3+} (Grassy Green)

FLAME COLOURS

Ca^{2+} (Brick Red)

Cu^{2+} (Bluish Green)

APPARATUS

China Dish

Test Tubes

Test Tube Holder

Tripod Stand

FLAME TEST PROCEDURE

hydrochloric acid

Bunsen Burner

(Salt + HCl) Paste

Ca^{2+} (Brick Red)

Bunsen Burner

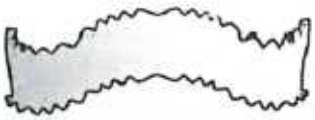
FILTER ASH TEST PROCEDURE

Salt solution + cobalt nitrate solution

Filter paper dipped in solution

Filter paper burning

Zn^{2+} (Green ash)



Al^{3+} (Blue ash)

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PRACTICAL BASED ASSESSMENT (PBA) TEST-2 Marks 06

Q. A student was given a 0.100 M sodium carbonate (Na_2CO_3) solution, labelled as solution B. A sample of solution A (hydrochloric acid, HCl) was provided. Solution B was titrated against solution A using an indicator. The following reaction occurs during the titration:

$$Na_2CO_3 + 2HCl \rightarrow 2NaCl + H_2O + CO_2$$

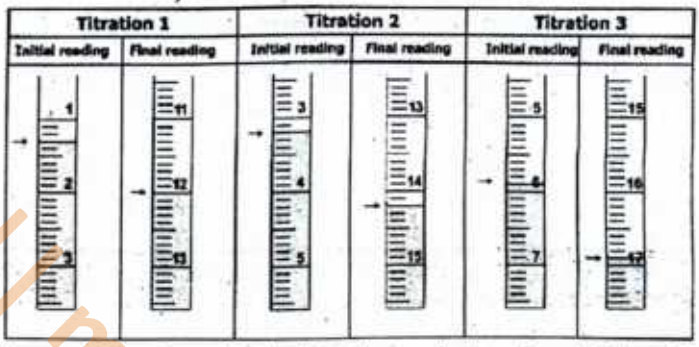
(a) Name a suitable indicator for this titration and state the colour change at the end point. **[1]**

(b) The burette was filled with HCl (solution A), and 25.0 cm^3 of solution B was pipetted into a conical flask. After adding 2-3 drops of indicator, the titration was repeated until concordant results were obtained. Using the diagram provided, complete the table and determine the mean volume of HCl used. **[2]**

Observation Table:

Titration number	1	2	3
Final Reading (cm^3)			
First Reading (cm^3)			
Volume of HCl used (cm^3)			
Best titration result (✓)			

From best titration result,
the average volume of HCl used = _____ cm^3



(c) From the balanced equation, determine the stoichiometric coefficients and calculate the molarity of HCl in solution B using the titration data. **[2]**

(d) From the titration data, calculate the amount of HCl per dm^3 in solution A. (H=1, Cl=35.5) **[1]**

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SOLUTION PRACTICAL BASED ASSESSMENT (PBA) TEST-1 Marks 06

(a) $Na_2CO_3 + H_2SO_4 \rightarrow Na_2SO_4 + H_2O$

(b) The molarity of the Na_2CO_3 solution under test is determined with the help of the following equation:

$$\frac{\overset{Na_2CO_3}{M_1\ V_1}}{n_1} = \frac{\overset{H_2SO_4}{M_2\ V_2}}{n_2}$$

$$M_1 = \frac{M_2\ V_2}{n_2} \times \frac{n_1}{V_1}$$

$$M_1 = \frac{0.0500 \times 25.0}{1} \times \frac{1}{25.0} = 0.0500\ M$$

(c) Molar mass of Na_2CO_3 = $23 \times 2 + 12 + 16 \times 3 = 106\ g\ mol^{-1}$

Mass of Na_2CO_3 per dm^3 = Molarity (M_1) × Molar mass of Na_2CO_3

= 0.0500 × 106 = $5.30\ g\ dm^{-3}$

Since $1\ dm^3 = 1000\ cm^3$, so

1000 cm^3 solution contains Na_2CO_3 = 5.30 g

1 cm^3 solution contains Na_2CO_3 = $\frac{5.30}{1000}$ g

500 cm^3 solution contains Na_2CO_3 = $\frac{5.30}{1000} \times 500 = 2.65$ g

(d) Indicator: Methyl orange

Colour change: Yellow to orange red at end point.

SOLUTION PRACTICAL BASED ASSESSMENT (PBA) TEST-2 Marks 06

(a) Indicator : Methyl orange

Colour change : Yellow to orange red at end point.

(b)

Titration number	1	2	3
Final Reading (cm^3)	12.0	14.2	16.9
First Reading (cm^3)	1.3	3.2	5.9
Volume of HCl used (cm^3)	10.7	11.0	11.0
Best titration result (✓)		✓	✓

From best titration result,
the average volume of HCl used = 11.0 cm^3

(c) The balanced equation is $Na_2CO_3 + 2HCl \rightarrow 2NaCl + H_2O + CO_2$

So, the mole ratio is $n_1 = 1$ $n_2 = 2$

The molarity of HCl is given as

$$\frac{\overset{HCl}{M_1\ V_1}}{n_1} = \frac{\overset{Na_2CO_3}{M_2\ V_2}}{n_2}$$

$$M_1 = \frac{M_2\ V_2}{n_2} \times \frac{n_1}{V_1}$$

$$M_1 = \frac{0.100 \times 25.0}{1} \times \frac{2}{11.0} = 0.455\ M$$

(d) Molar mass of HCl = $1 + 35.5 = 36.5\ g\ mol^{-1}$

Mass of HCl per dm^3 = Molarity (M_1) × Molar mass of Na_2CO_3

= 0.455 × 36.5

= $16.6\ g\ dm^{-3}$

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Experiment 1-A

Determine the amount of NaOH in 250 cm^3 of given solution by volumetric analysis.

Apparatus used: Burette, pipette, funnel, conical flask, beakers, iron stand.

Chemicals used: Phenolphthalein, Standard solution of H_2SO_4, 0.05M; Distilled water, given solution of NaOH

Chemical Equation:

$$NaOH + H_2SO_4 \rightarrow NaHSO_4 + H_2O$$
$$NaOH + NaHSO_4 \rightarrow Na_2SO_4 + H_2O$$

Overall Reaction

$$2NaOH + H_2SO_4 \rightarrow Na_2SO_4 + 2H_2O$$

Standard Solution: 0.05 M H_2SO_4

Mole Ratio from balanced equation:

NaOH	:	H_2SO_4
2	:	1

Indicator used: Phenolphthalein

End Point: Light pink, almost colourless

NOTE:
- Burette reading up to one decimal place 1 d.p. and three significant figures 3 s.f. Pipette reading also with 3 s.f.
- Molarity of standard solution is ***defined with nominal value*** of 0.05M. So, it is treated as exact and does not limit s.f.

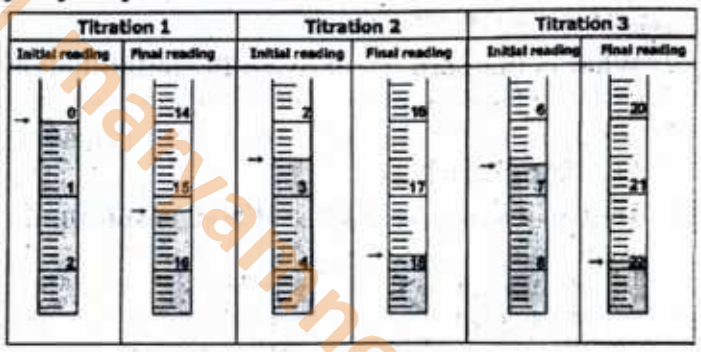
Procedure:
- Fill the burette with H_2SO_4 solution
- Pipette out 10.0 cm^3 NaOH solution in a titration flask
- Add 2-3 drops of phenolphthalein as an indicator
- Titrate NaOH solution against H_2SO_4 solution till the end point is reached.

Instructions:

Repeat the titration as many time as you think necessary to obtain accurate results.
Make certain that the recorded results show the accuracy of your practical work.

Observation Table:

Titration number	1	2	3
Final Reading (cm^3)	15.2	17.8	21.9
First Reading (cm^3)	0.0	2.5	6.6
Volume of H_2SO_4 used (cm^3)	15.2	15.3	15.3
Best titration result (✓)	✓	✓	✓



From best titration result,
the average volume of H_2SO_4 used = 15.3 cm^3

Calculations:

(a) Data for given titration

M_1 = Molarity of NaOH = ?
M_2 = Molarity of H_2SO_4 = 0.05 M
V_1 = Volume of NaOH solution taken = 10.0 cm^3
V_2 = Volume of H_2SO_4 solution used = 15.3 cm^3
n_1 = Number of moles of NaOH in balanced equation = 2
n_2 = Number of moles of H_2SO_4 in balanced equation = 1

(b) Calculation of molarity using the formula $\frac{M_1 V_1}{n_1} = \frac{M_2 V_2}{n_2}$

The molarity of the NaOH solution under test is determined with the help of the following equation:

NaOH **H_2SO_4**

$$\frac{M_1 V_1}{n_1} = \frac{M_2 V_2}{n_2}$$

$$M_1 = \frac{M_2 V_2}{n_2} \times \frac{n_1}{V_1} = \frac{0.05 \times 15.3}{1} \times \frac{2}{10.0} = 0.153\ M$$ 3 s.f.

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(c) Calculate mass of NaOH, per dm^3 from "b" by using formula:

Molar mass of NaOH = $23 \times 1 + 16 \times 1 + 1 \times 1 = 40\ g\ mol^{-1}$

Mass of NaOH per dm^3 = Molarity (M_1) × Molar mass of NaOH

= 0.153 × 40

= $6.12\ g\ dm^{-3}$ [3 s.f.]

Calculate mass of NaOH in 250 cm^3

Since 1 dm^3 = 1000 cm^3, so from (c),

1000 cm^3 solution contains NaOH = 6.12 g

1 cm^3 solution contains NaOH = $\frac{6.12}{1000}$ g

250 cm^3 solution contains NaOH = $\frac{6.12}{1000} \times 250$

= 1.53 g [3 s.f.]

Result: Amount of NaOH in 250 cm^3 solution = 1.53 g

VIVA VOCE

1. Which indicator is used for titration of a strong base with acid?

Ans: Phenolphthalein

2. What is the color of phenolphthalein in acidic and basic media?

Ans: Acidic medium: Colorless

Basic medium: Pink

3. What is the purpose of using Phenolphthalein?

Phenolphthalein is an indicator used in titration of a strong base with strong acid. It is colorless in acidic medium and pink in basic medium. So, when acid-base reaction is completed in titration, it changes its color which indicates the endpoint.

4. How will you prepare 0.2 M NaOH solution?

Ans:

Mass of NaOH = m = ?

Molar mass of NaOH = M = 23+16+1= 40 g mol^{-1}

Volume of solution = V = 1.0 dm^3

Molarity = 0.20 M

So, $\text{Molarity} = \frac{m}{M} \times \frac{1}{V}$

or $m = \text{Molarity} \times M \times V$

$= 0.20 \times 40 \times 1.0 = 8.0\ g$

Thus 8 g of NaOH are taken in a 1 dm^3 flask and the volume of solution is made upto the mark (i.e. 1 dm^3) with distilled water.

5. Calculate the molarity of a solution containing 12.25 g of H_2SO_4 in 250 cm^3 of solution.

Ans:

Mass of H_2SO_4 = m = 12.25 g

Molar mass of H_2SO_4 = M = 98 g/mol

Volume of solution = V = 250 cm^3 = $\frac{250}{1000}$ = 0.25 dm^3

Molarity = ?

So $\text{Molarity} = \frac{m}{M} \times \frac{1}{V} = \frac{12.25}{98} \times \frac{1}{0.25} = 0.50\ M$

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PRACTICAL BASED ASSESSMENT (PBA) TEST Marks 06

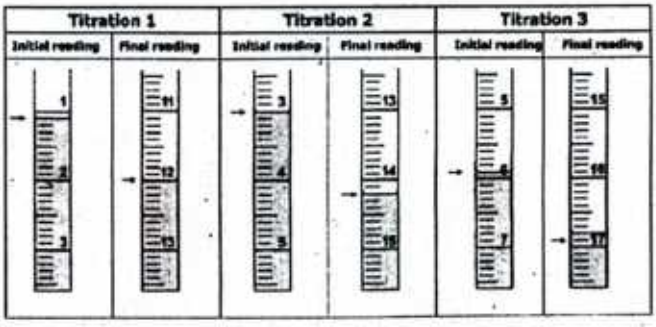
Q. A 10.0 g sample of potassium hydroxide (KOH) was dissolved in 500 cm³ of distilled water to prepare solution B. A 0.10 M hydrochloric acid (HCl) solution was provided as solution A. During titration, 10.0 cm³ of solution B was transferred into a conical flask, and 2–3 drops of phenolphthalein were added. The solution was titrated with solution A until the indicator changed colour at the endpoint. The titration was repeated to obtain concordant results.

(a) The burette contained 0.100 M HCl. Using the figure provided, record the titration readings and calculate the mean titre (average volume) of HCl required to neutralize the alkali. **[2]**

Observation Table:

Titration number	1	2	3
Final Reading (cm³)			
First Reading (cm³)			
Volume of HCl used (cm³)			
Best titration result (✓)			

From best titration result,
the average volume of HCl used: _____ cm³



(b) Using the balanced equation above:

(i) Write the equation and state the mole ratio of KOH to HCl. **[1]**

(ii) Calculate the molarity of KOH using the mean volume of acid obtained from (b). **[1]**

(c) From your calculated molarity, determine: **[1+1]**

(i) The mass of KOH present in 500 cm³ of the mixture. *(K = 39, O = 16, H = 1)*

(ii) The percentage purity of KOH

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SOLUTION PRACTICAL BASED ASSESSMENT (PBA) TEST Marks 06

(a)

Titration number	1	2	3
Final Reading (cm^3)	12.0	14.2	16.8
First Reading (cm^3)	1.1	3.0	5.9
Volume of HCl used (cm^3)	10.9	11.2	10.9
Best titration result (✓)	✓		✓

From best titration result,
the average volume of HCl used = 10.9 cm^3

(b)

(i) The balanced equation is: $KOH + HCl \rightarrow KCl + H_2O$
So, the mole ratio is $n_1 = 1$ $n_2 = 1$

(ii)

$$\underset{\text{KOH}}{\frac{M_1 V_1}{n_1}} = \underset{\text{HCl}}{\frac{M_2 V_2}{n_2}}$$

$$M_1 = \frac{M_2 V_2}{n_2} \times \frac{n_1}{V_1}$$

$$= \frac{0.10 \times 10.9}{1} \times \frac{1}{10.0} = 0.109\ M$$

(c) (i)

Molar mass of KOH = $39 \times 1 + 16 \times 1 + 1 \times 1 = 56\ g\ mol^{-1}$
Mass of KOH per dm^3 = Molarity (M_1) × Molar mass of KOH
= 0.109 × 56 = 6.10 g dm^{-3}

Since 1 dm^3 = 1000 cm^3, therefore, mass of KOH, per 500 cm^3 is:
1000 cm^3 solution contains KOH = 6.10 g
1 cm^3 solution contains KOH = $\frac{6.10}{1000}$ g
500 cm^3 solution contains KOH = $\frac{6.10}{1000} \times 500 = 3.05$ g

(ii) Percentage of KOH = $\frac{\text{Mass of KOH obtained from calculations in 'c (i)'}}{\text{Initial mass of KOH dissolved per 500 cm}^3} \times 100$

Percentage of KOH = $\frac{3.05}{10.0} \times 100 = 30.5\%$

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02 EXPERIMENT

The given solution contains 6g of Na_2CO_3 dissolved per dm^3. Determine the percentage purity of the sample solution by volumetric method.

Apparatus used:

Burette, pipette, funnel, conical flask, beakers, iron stand.

Chemicals used:

Methyl orange, 0.1M HCl, Distilled water, solution of 6g of Na_2CO_3 per dm^3

Chemical Equation:

$$Na_2CO_3 + HCl \rightarrow NaHCO_3 + H_2O$$
$$NaHCO_3 + HCl \rightarrow NaCl + H_2O + CO_2$$

Overall Reaction

$$Na_2CO_3 + 2HCl \rightarrow 2NaCl + H_2O + CO_2$$

Standard Solution:

0.1 M HCl

Mole Ratio from balanced equation:

Na_2CO_3	:	HCl
1	:	2

Indicator used:

Methyl orange

End Point:

Orange red

Procedure:

- Weigh out 6 g of Na_2CO_3 mixture and dissolve in 1 dm^3 (1000 cm^3) flask.
- Fill the burette with HCl solution
- Pipette out 10.0 cm^3 Na_2CO_3 solution in a titration flask
- Add 2-3 drops of methyl orange as an indicator
- Titrate Na_2CO_3 solution against HCl solution till the end point is reached.

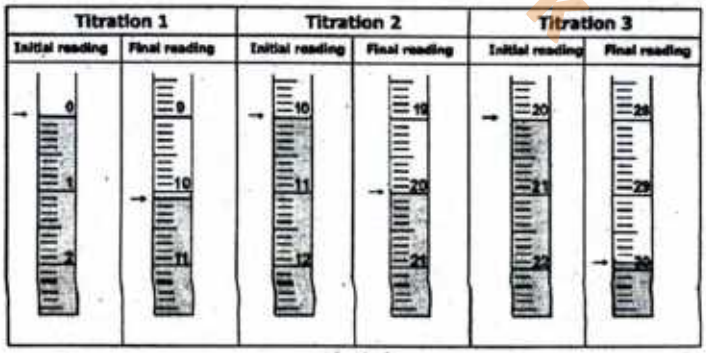
Instructions:

Repeat the titration as many time as you think necessary to obtain accurate results.
Make certain that the recorded results show the accuracy of your practical work.

Observation Table:

Titration number	1	2	3
Final Reading (cm^3)	10.1	20.0	29.9
First Reading (cm^3)	0.0	10.0	20.0
Volume of HCl used (cm^3)	10.1	10.0	9.9
Best titration result (✓)	✓	✓	✓

From best titration result,
the average volume of HCl used = 10.0 cm^3



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Calculations:

(a) Data for given titration

M_1 = Molarity of Na_2CO_3 = ?
M_2 = Molarity of HCl = 0.1 M
V_1 = Volume of Na_2CO_3 solution taken = 10.0 cm^3
V_2 = Volume of HCl solution used = 10.0 cm^3
n_1 = Number of moles of Na_2CO_3 in balanced equation = 1
n_2 = Number of moles of HCl in balanced equation = 2

(b) Calculation of molarity using the formula $\frac{M_1 V_1}{n_1} = \frac{M_2 V_2}{n_2}$

The molarity of the Na_2CO_3 solution under test is determined with the help of the following equation:

$$\underset{\frac{M_1 V_1}{n_1}}{Na_2CO_3} = \underset{\frac{M_2 V_2}{n_2}}{HCl}$$

$$M_1 = \frac{M_2 V_2}{n_2} \times \frac{n_1}{V_1}$$

$$M_1 = \frac{0.1 \times 10.0}{2} \times \frac{1}{10.0}$$

$$M_1 = 0.05\ M$$

(c) Calculate mass of Na_2CO_3, per dm^3 from "b" by using formula: ***[Na= 23, O= 16, C= 12]***

Molar mass of Na_2CO_3 $= 23 \times 2 + 12 \times 1 + 16 \times 3 = 106\ g\ mol^{-1}$

Mass of Na_2CO_3 per dm^3 = Molarity (M_1) × Molar mass of Na_2CO_3
= 0.05 × 106
= 5.3 g dm^{-3}

(d) Percentage purity is calculated by formula:

$$\text{Percentage purity } Na_2CO_3 = \frac{\text{Mass of } Na_2CO_3 \text{ obtained from calculations in 'c'}}{\text{Initial mass of } Na_2CO_3 \text{ dissolved per } dm^3} \times 100$$

$$\text{Percentage purity of } Na_2CO_3 = \frac{5.3}{6.0} \times 100$$

Percentage purity of Na_2CO_3 = 88 %

Given mass is 6g or 6.0g

Result:

Percentage purity of Na_2CO_3 = 88 %

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VIVA VOCE

1. What is volumetric analysis?

Ans: It is a type of analysis in which amount of a substance is measured in a solution by volume measurement. e.g. acid-base titration

2. What is an acid-base titration?

Ans: It is volumetric analysis in which the concentration of unknown acid or base solution is measured by the reaction between acid and base. An indicator is used which changes its colour with the change in pH.

3. What is an indicator? Which indicator is commonly used in acid-base titrations?

Ans: It is a chemical substance which changes its colour and shows the completion of a reaction.
For acid-base titrations, commonly used indicators are; phenolphthalein, methyl orange, etc.

4. What is the name of indicator used for the titration of Na_2CO_3 and HCl?

Ans: Na_2CO_3 is a weak base. So, methyl orange is used as an indicator for the titration of Na_2CO_3 and HCl. It is pink in base and orange red in acid. During titration, it changes color to orange red in the acidic range.

5. What is neutralization reaction? Give one example.

Ans: A chemical reaction between an acid and a base, resulting in the formation of water and a salt.

$$HCl + NaOH \rightarrow H_2O + NaCl$$

6. How does the choice of indicator affect the accuracy of a volumetric titration?

Ans: The choice of indicator affects the accuracy of a volumetric titration because it indicates the completion of the reaction by changing their color.

7. What are some common sources of error in volumetric titration?

Ans. Common sources of error in volumetric titration include inaccurate measurements of volumes, improper mixing, and incomplete reaction

8. How could you improve the accuracy of your percentage purity calculation in future experiments?

Ans: To improve the accuracy of your percentage purity calculation in future experiments, you could ensure precise measurements, conduct multiple trials.

9. Write names of the following apparatus used in volumetric analysis.

(a)

(b)

Ans: **(a)** Burette: It is used to measure variable volume of liquids very accurately.
(b) Pipette: It is to measure out fixed volumes of liquids very accurately.

10. For what purpose this apparatus is used? Write the name of this apparatus

Ans: The name of the apparatus is conical Flask . It is used in the titration process and hence also known as "Titration Flask". For titration, a measured amount of solution is taken in this conical flask.

11. Define molarity.

Ans: It is the number of moles of solute dissolved per dm^3 of solution. It is denoted by 'M'.

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It is determined by the formula

$$M = \frac{\text{Number of moles of solute}}{\text{Volume of solution in dm}^3}$$

or $$M = \frac{\text{Mass of solute}}{\text{Molar mass of solute}} \times \frac{1}{\text{Volume of solution in dm}^3}$$

12. The molarity of given Li_2CO_3 solution is 0.10 M. Calculate the mass of Li_2CO_3 in 100 cm^3 of solution. [Li= 7, O= 16 , C= 12]

Ans: Molar mass of $Li_2CO_3 = 7 \times 2 + 12 \times 1 + 16 \times 3 = 74\ g\ mol^{-1}$

Mass of Li_2CO_3 per dm^3 = Molarity × Molar mass of Li_2CO_3
= 0.10 × 74
= 7.4 g dm^{-3}

Since 1 dm^3 = 1000 cm^3,

So, 1000 cm^3 solution contains Li_2CO_3 = 7.4 g

1 cm^3 solution contains Li_2CO_3 = $\frac{7.4}{1000}$ g

100 cm^3 solution contains Li_2CO_3 = $\frac{7.4}{1000} \times 100 = 0.74$ g

13. Calculate the molarity of given Na_2CO_3 solution from the following data
M_2 = Molarity of HCl=0.1M V_1 = Volume of Na_2CO_3 solution taken=10.0 cm^3
V_2 = Volume of HCl solution used = 9.5 cm^3

Ans: The overall balanced equation for the reaction is

$$Na_2CO_3 + 2HCl \rightarrow 2NaCl + H_2O + CO_2$$

So, the data becomes

M_1 = Molarity of Na_2CO_3 = ?
V_1 = Volume of Na_2CO_3 solution taken = 10.0 cm^3
n_1 = Number of moles of Na_2CO_3 = 1
M_2 = Molarity of HCl = 0.1 M
V_2 = Volume of HCl solution used = 9.5 cm^3
n_2 = Number of moles of HCl = 2

The molarity of the given Na_2CO_3 solution is determined with the help of the following equation:

$$\frac{M_1 V_1}{n_1} = \frac{M_2 V_2}{n_2}$$

$$M_1 = \frac{M_2 V_2}{n_2} \times \frac{n_1}{V_1} = \frac{0.1 \times 9.5}{2} \times \frac{1}{10.0} = 0.048\ M$$

14. Determine the percentage purity of the sample of Na_2CO_3 when the given solution contains 15.0 g of Na_2CO_3 dissolved per dm^3. The molarity of given Na_2CO_3 solution is 0.100 M. [Na=23, O=16, C= 12]

Ans: **(a)** Calculate mass of Na_2CO_3, per dm^3

Molar mass of Na_2CO_3 = $23 \times 2 + 12 \times 1 + 16 \times 3 = 106\ g\ mol^{-1}$
Mass of Na_2CO_3 per dm^3 = Molarity × Molar mass of Na_2CO_3
= 0.100 × 106 = 10.6 g dm^{-3}

(b) Percentage purity is calculated by formula:

$$\text{Percentage purity of } Na_2CO_3 = \frac{\text{Mass of } Na_2CO_3 \text{ obtained from calculations in 'a'}}{\text{Initial mass of } Na_2CO_3 \text{ dissolved per dm}^3} \times 100$$

$$\text{Percentage purity of } Na_2CO_3 = \frac{10.6}{15.0} \times 100 = 70.7\%$$

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PRACTICAL BASED ASSESSMENT (PBA) TEST Marks 06

Q. A student was provided with a mixture containing 5.00 g of Na_2CO_3 and Na_2SO_4 dissolved in 500 cm^3 of solution. A 10.0 cm^3 sample of this solution was titrated against standard HCl solution (0.100 M) from the burette using methyl orange indicator.

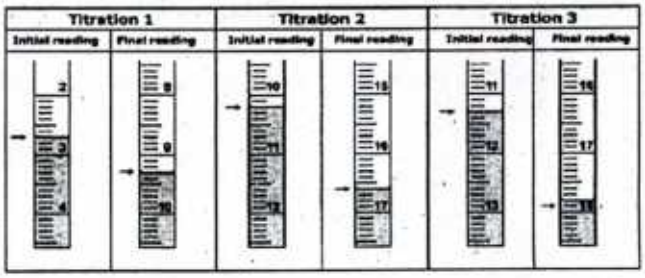
(a) When the titration between Na_2CO_3 and HCl is carried out using methyl orange, **[1]**

(i) what is the initial colour of the solution?

(ii) what is the colour at the end-point?

(b) Using the figure provided, record the titration readings and calculate the mean titre (average volume) of HCl required to neutralize the alkali. **[2]**

Titration number	1	2	3
Final Reading (cm^3)			
First Reading (cm^3)			
Volume of HCl used (cm^3)			
Best titration result (✓)			



From best titration result,
the average volume of HCl used = _____ cm^3

(c) When sodium carbonate reacts with hydrochloric acid, the equation is: **[1]**
$Na_2CO_3 + 2HCl \rightarrow 2NaCl + H_2O + CO_2$ Using this equation and the mean titre value from (b), calculate the molarity of Na_2CO_3 solution. *[Na= 23, O= 16, C= 12]*

(d) Calculate:

(i) the mass of Na_2CO_3 per dm^3 and the mass of Na_2CO_3 in 500 cm^3 **[1]**

(ii) the percentage composition of Na_2CO_3 and Na_2SO_4 in the mixture. **[1]**

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SOLUTION PRACTICAL BASED ASSESSMENT (PBA) TEST Marks 06

(a) (i) Yellow
(ii) Orange red

(b)

Titration number	1	2	3
Final Reading (cm^3)	9.30	16.60	17.80
First Reading (cm^3)	2.70	10.20	11.30
Volume of HCl used (cm^3)	6.60	6.40	6.50
Best titration result (✓)	✓	✓	✓

From best titration result,
the average volume of HCl used = 6.50 cm^3

(c) From the balanced equation, $Na_2CO_3 + 2HCl \rightarrow 2NaCl + H_2O + CO_2$
The mole ratio is $n_1 = 1$ $n_2 = 2$.

Thus, molarity of Na_2CO_3 is:

$$\underset{n_1}{\frac{M_1 V_1}{}} = \underset{n_2}{\frac{M_2 V_2}{}}$$

Na_2CO_3 HCl

$$M_1 = \frac{M_2 V_2}{n_2} \times \frac{n_1}{V_1}$$

$$= \frac{0.100 \times 6.50}{2} \times \frac{1}{10.0}$$

$$= 0.0325 \text{ M}$$

(d) (i) Molar mass of $Na_2CO_3 = 23 \times 2 + 12 \times 1 + 16 \times 3 = 106 \text{ g mol}^{-1}$
Mass of Na_2CO_3 per dm^3 = Molarity (M_1) × Molar mass of Na_2CO_3
= 0.0325 × 106
= 3.45 g dm^{-3}

Since 1 dm^3 = 1000 cm^3, so from (c),
1000 cm^3 solution contains Na_2CO_3 = 3.45 g
1 cm^3 solution contains Na_2CO_3 = $\frac{3.45}{1000}$ g
500 cm^3 solution contains Na_2CO_3 = $\frac{3.45}{1000} \times 500 = 1.73$ g

(ii) **Percentage of Na_2CO_3** = $\frac{\text{Mass of } Na_2CO_3 \text{ obtained from calculations in 'd(i)'}}{\text{Initial mass of } Na_2CO_3 \text{ dissolved per 500 cm}^3} \times 100$

Percentage of Na_2CO_3 = $\frac{1.73}{5.00} \times 100 = 34.5\%$

Percentage of Na_2SO_4 = 100 − Percentage of Na_2CO_3 = 100 − 34.5 = 65.5%

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Experiment 2-A

The given solution contains 5.0 g of $NaHCO_3$ dissolved per 500 cm^3. Determine the percentage purity of the sample solution by volumetric method.

Apparatus used: Burette, pipette, funnel, conical flask, beakers, iron stand.

Chemicals used: Methyl orange, 0.1M HCl, Distilled water, solution of 5.0 g of $NaHCO_3$ in 500 cm^3

Chemical Equation: $NaHCO_3 + HCl \rightarrow NaCl + H_2O + CO_2$

Standard Solution:
0.1 M HCl

Mole Ratio from balanced equation:

$NaHCO_3$	:	HCl
1	:	1

Indicator used: Methyl orange

End Point: Orange red

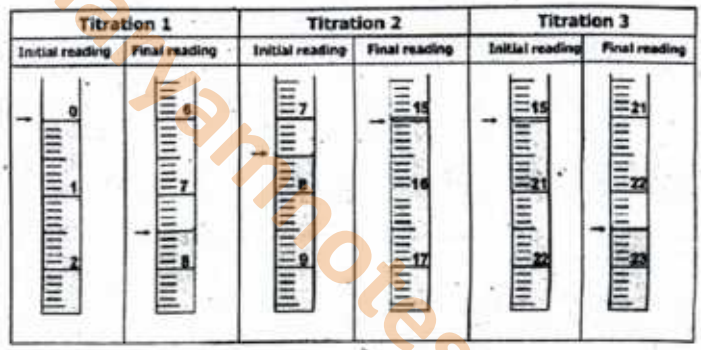
NOTE:
- Burette reading up to two decimal places (2 d.p.) and three significant figures (3 s.f.). Pipette reading also with 3 s.f.
- Molarity of standard solution is ***defined with nominal value*** of 0.1M. So, it is treated as exact and does not limit s.f.

Procedure:
- Weigh out 5.0 g of $NaHCO_3$ mixture and dissolve in 500 cm^3 flask.
- Fill the burette with HCl solution
- Pipette out 10.0 cm^3 $NaHCO_3$ solution in a titration flask
- Add 2-3 drops of methyl orange as an indicator
- Titrate $NaHCO_3$ solution against HCl solution till the end point is reached.

Instructions:
Repeat the titration as many time as you think necessary to obtain accurate results.
Make certain that the recorded results show the accuracy of your practical work.

Observation Table:

Titration number	1	2	3
Final Reading (cm^3)	7.50	15.05	22.50
First Reading (cm^3)	0.0	7.50	15.05
Volume of HCl used (cm^3)	7.50	7.55	7.45
Best titration result (✓)	✓	✓	✓



From best titration result,
the average volume of HCl used = 7.50 cm^3 **3 s.f.**

Calculations:

(a) Data for given titration

M_1 = Molarity of $NaHCO_3$ = ?
M_2 = Molarity of HCl = 0.1 M
V_1 = Volume of $NaHCO_3$ solution taken = 10.0 cm^3
V_2 = Volume of HCl solution used = 7.50 cm^3
n_1 = Number of moles of $NaHCO_3$ in balanced equation = 1
n_2 = Number of moles of HCl in balanced equation = 1

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(b) Calculation of molarity using the formula $\frac{M_1 V_1}{n_1} = \frac{M_2 V_2}{n_2}$

The molarity of the $NaHCO_3$ solution under test is determined with the help of the following equation:

$$\underset{\frac{M_1 V_1}{n_1}}{NaHCO_3} = \underset{\frac{M_2 V_2}{n_2}}{HCl}$$

$$M_1 = \frac{M_2 V_2}{n_2} \times \frac{n_1}{V_1}$$

$$M_1 = \frac{0.1 \times 7.50}{1} \times \frac{1}{10.0}$$

$$M_1 = 0.0750\ M \qquad \boxed{3\ s.f.}$$

(c) Calculate mass of $NaHCO_3$, per dm^3 from "b" by using formula:

Mass of* $NaHCO_3$ *per* dm^3 = *Molarity* (M_1) × *Molar mass of* $NaHCO_3$ *[Na= 23, O= 16 , C= 12]

Molar mass of $NaHCO_3 = 23 \times 1 + 1 \times 1 + 12 \times 1 + 16 \times 3 = 84\ g\ mol^{-1}$

Mass of $NaHCO_3$ per dm^3 = Molarity (M_1) × Molar mass of $NaHCO_3$

$= 0.0750 \times 84 = 6.30\ g\ dm^{-3}$

(d) Calculate mass of $NaHCO_3$ in 500 cm^3

Since $1\ dm^3 = 1000\ cm^3$, so from (c),

$1000\ cm^3$ solution contains $NaHCO_3 = 6.30\ g$

$1\ cm^3$ solution contains $NaHCO_3 = \frac{6.30}{1000}\ g$

$500\ cm^3$ solution contains $NaHCO_3 = \frac{6.30}{1000} \times 500 = 3.15\ g$

(e) Percentage purity is calculated by formula:

$$\text{Percentage purity of } NaHCO_3 = \frac{\text{Mass of } NaHCO_3 \text{ obtained from calculations in 'd'}}{\text{Initial mass of } NaHCO_3 \text{ dissolved per 500 } cm^3} \times 100$$

$$\text{Percentage purity of } NaHCO_3 = \frac{3.15}{5.0} \times 100 = 63\ \%$$

Result: Percentage purity of $NaHCO_3 = 63\ \%$

VIVA VOCE

1. What are concordant readings in volumetric analysis?

Ans: The burette reading which do not differ by more than 0.1 cm^3 are called concordant reading

2. What is the use of volumetric titration in chemistry?

Ans: In chemistry, the volumetric titration is used to determine the concentration of a substance in a solution by volume measurements.

3. What is the common name of sodium carbonate?

Ans: Soda ash & Washing soda

4. What is the common name of sodium bicarbonate?

Ans: Baking soda

5. What is endpoint?

Ans: At endpoint, the indicator changes color, indicating that the reaction is complete.

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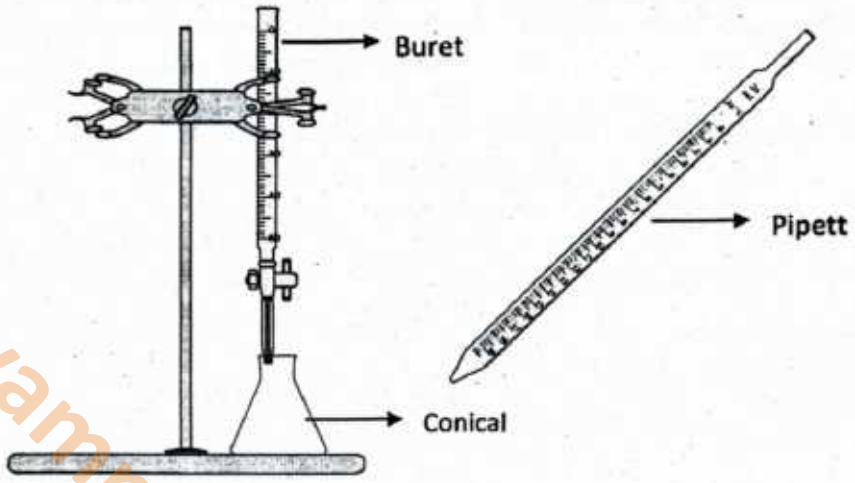
6. Label the indicated apparatus



The mass of $NaHCO_3$ in a 500 cm^3 is 6.40 g. Calculate the mass of $NaHCO_3$ in 100 cm^3 of solution.

Ans: 500 cm^3 solution contains $NaHCO_3$ = 6.40 g

1 cm^3 solution contains $NaHCO_3$ = $\frac{6.40}{500}$ g

100 cm^3 solution contains $NaHCO_3$ = $\frac{6.40}{500} \times 100 = 1.28$ g

7. A given HCl solution is 0.1 M. How will you prepare 500 cm^3 of 0.025 M HCl solution from this given solution?

Ans: The dilution formula is

Given concentration = Required concentration

$$M_1V_1 = M_2V_2$$

$$0.1 \times V_1 = 0.025 \times 500$$

$$V_1 = \frac{0.025 \times 500}{0.1}$$

$$V_1 = 125\ cm^3$$

Measure 125 cm^3 volume by measuring cylinder from 0.1 M HCl solution. Pour into 500 cm^3 volumetric flask and make up, up to the mark by water.

8. Determine the composition of the sample $NaHCO_3$ and $Na_2C_2O_4$. 10 g of this mixture has been dissolved per dm^3 of solution. The molarity of the solution was found to be 0.05 M.

[Na=23, O=16, C= 12, H = 1]

Ans: (a) Mass of $NaHCO_3$, per dm^3 is calculated

Molar mass of $NaHCO_3$ = $23 \times 1 + 1 \times 1 + 12 \times 1 + 16 \times 3 = 84\ g\ mol^{-1}$

Mass of $NaHCO_3$ per dm^3 = Molarity × Molar mass of $NaHCO_3$

= 0.05 × 84

= 4.2 g dm^{-3}

(b) Percentage is calculated by formula:

$$\text{Percentage of } NaHCO_3 = \frac{\text{Mass of } NaHCO_3 \text{ obtained from calculations in 'a'}}{\text{Initial mass of } NaHCO_3 \text{ mixture dissolved per } dm^3} \times 100$$

$$\text{Percentage of } NaHCO_3 = \frac{4.2}{10} \times 100 = 42\%$$

So, Percentage of $Na_2C_2O_4$ = 100 – 42 = 58%

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PRACTICAL BASED ASSESSMENT (PBA) TEST Marks 06

Q. A 10 cm^3 portion of potassium hydrogen carbonate ($KHCO_3$) solution was titrated with 0.1 mol dm^{-3} hydrochloric acid (HCl) using methyl orange as the indicator.

(a) Write a balanced chemical equation for the reaction between $KHCO_3$ and HCl. **[1]**

(b) State the colour change of methyl orange at the end-point of this titration. **[1]**

(c) From the balanced equation, determine the mole ratio ($n_1 : n_2$) between $KHCO_3$ and HCl. **[1]**

(d) If the mean titre of 0.10 mol dm^{-3} HCl used is 5.8 cm^3, calculate the molarity of $KHCO_3$ solution **[1]**

(e) Using your result from (d), calculate the mass of $KHCO_3$ in 1 dm^3 of solution. *[K=39, O=16, C=12, H=1]* **[1]**

(f) Calculate the mass of $KHCO_3$ present in 500 cm^3 of the solution. **[1]**

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SOLUTION PRACTICAL BASED ASSESSMENT (PBA) TEST Marks 06

(a) $KHCO_3 + HCl \rightarrow KCl + CO_2 + H_2O$

(b) Initially yellow to orange red at the end point

(c) $KHCO_3 + HCl \rightarrow KCl + CO_2 + H_2O$

Mole ratio $n_1 = 1$ $n_2 = 1$

(d)

$KHCO_3$ **HCl**

$$\frac{M_1 V_1}{n_1} = \frac{M_2 V_2}{n_2}$$

$$M_1 = \frac{M_2 V_2}{n_2} \times \frac{n_1}{V_1}$$

$$= \frac{0.10 \times 5.8}{1} \times \frac{1}{10} = 0.058 \text{ M}$$

(e)

Molar mass of $KHCO_3$ $= 39 + 1 + 12 + 16 \times 3 = 100 \text{ g mol}^{-1}$

Mass of $KHCO_3$ per dm^3 = Molarity (M_1) × Molar mass of $KHCO_3$

= 0.058 × 100

= 5.8 g dm^{-3}

(f)

Since 1 dm^3 = 1000 cm^3,

So

1000 cm^3 solution contains $KHCO_3$ = 5.8 g

1 cm^3 solution contains $KHCO_3$ = $\frac{5.8}{1000}$ g

500 cm^3 solution contains $KHCO_3$ = $\frac{5.8}{1000} \times 500 = 2.9$ g

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03 EXPERIMENT

Determine the Value of 'x' by Volumetric Method in the given sample of 6.3g of $(COOH)_2 . xH_2O$ dissolved per dm^3

Apparatus used:

Burette, pipette, funnel, conical flask, beakers, iron stand.

Chemicals used:

Phenolphthalein, Standard solution of NaOH, 0.1M; Distilled water, 6.3 g of $H_2C_2O_4 . xH_2O$ dissolved per dm^3

Chemical Equation:

$$NaOH + \begin{matrix}COOH\\|\\COOH\end{matrix} \cdot xH_2O \rightarrow \begin{matrix}COONa\\|\\COOH\end{matrix} + (x+1)\,H_2O$$

$$NaOH + \begin{matrix}COONa\\|\\COOH\end{matrix} \rightarrow \begin{matrix}COONa\\|\\COONa\end{matrix} + H_2O$$

$$\text{Overall reaction } 2NaOH + \begin{matrix}COOH\\|\\COOH\end{matrix} \cdot xH_2O \rightarrow \begin{matrix}COONa\\|\\COONa\end{matrix} + (x+2)\,H_2O$$

Standard Solution:

0.1 M NaOH

Mole Ratio from balanced equation:

NaOH	:	$H_2C_2O_4 . xH_2O$
2	:	1

Indicator used:

Phenolphthalein

End Point:

Light pink

Note: *Oxalic acid is*

$$\begin{matrix}COOH\\|\\COOH\end{matrix} \cdot 2H_2O$$

or $(COOH)_2.2H_2O$ or $H_2C_2O_4.2H_2O$

Procedure:

- 6.3g of $H_2C_2O_4 . xH_2O$ are dissolved per dm^3 of solution
- Fill the burette with $H_2C_2O_4 . xH_2O$ solution
- Pipette out 10.0 cm^3 NaOH solution in a titration flask
- Add 2-3 drops of phenolphthalein as an indicator
- Titrate NaOH solution against $H_2C_2O_4 . xH_2O$ solution till the end point is reached.

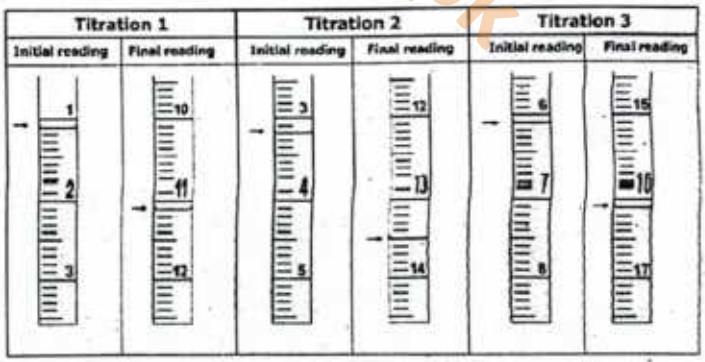
Instructions:

Repeat the titration as many time as you think necessary to obtain accurate results.
Make certain that the recorded results show the accuracy of your practical work.

Observation Table:

Titration number	1	2	3
Final Reading (cm^3)	11.1	13.5	16.1
First Reading (cm^3)	1.1	3.2	6.1
Volume of $H_2C_2O_4 . xH_2O$ used (cm^3)	10.0	10.3	10.0
Best titration result (✓)	✓		✓

From best titration result,
the average volume of $H_2C_2O_4 . xH_2O$ used = 10.0 cm^3



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Calculations:

(a) Data for given titration

M_1 = Molarity of $H_2C_2O_4 . xH_2O$ = ?
M_2 = Molarity of NaOH = 0.1 M
V_1 = Volume of $H_2C_2O_4 . xH_2O$ solution used = 10.0 cm^3
V_2 = Volume of NaOH solution taken = 10.0 cm^3
n_1 = Number of moles of $H_2C_2O_4 . xH_2O$ in balanced equation = 1
n_2 = Number of moles of NaOH in balanced equation = 2

(b) Calculation of molarity

The molarity of the oxalic acid solution under test is determined with the help of the following equation:

$$\underset{\text{n}_1}{\underset{\text{M}_1\ \text{V}_1}{\mathbf{H_2C_2O_4 . xH_2O}}} \quad \underset{\text{n}_2}{\underset{\text{M}_2\ \text{V}_2}{\mathbf{NaOH}}}$$

$$\frac{M_1 V_1}{n_1} = \frac{M_2 V_2}{n_2}$$

$$M_1 = \frac{M_2 V_2}{n_2} \times \frac{n_1}{V_1}$$

$$M_1 = \frac{0.1 \times 10.0}{2} \times \frac{1}{10.0}$$

$$M_1 = 0.05\ M$$

(c) Calculate number of water of crystallization in $H_2C_2O_4 . xH_2O$ from "b". *[H=1, O=16 , C=12]*

Given mass of $H_2C_2O_4 . xH_2O$ dissolved per dm^3 = 6.3 g
Molar mass of $H_2C_2O_4 . xH_2O$ = $12 \times 2 + 16 \times 4 + 1 \times 2 + 18x$ = $90 + 18x$

Mass of $H_2C_2O_4 . xH_2O$ per dm^3 = Molarity (M_1) × Molar mass of $H_2C_2O_4 . xH_2O$

$$6.3 = 0.05 \times (90 + 18x)$$

$$90 + 18x = \frac{6.3}{0.05}$$

$$90 + 18x = 126$$

$$18x = 126 - 90$$

$$18x = 36$$

$$x = \frac{36}{18} = 2$$

Result:

The value of 'x' in $H_2C_2O_4 . xH_2O$ = 2
Thus, there are two water of crystallization in oxalic acid.

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VIVA VOCE

1. What is water of crystallization?

Ans: The water molecules, which are attached with compound when crystallized from aqueous solution, are called water of crystallization.

Examples

$H_2C_2O_4 . xH_2O$ (Oxalic acid) $Na_2CO_3 . 10H_2O$

2. What are hydrates?

Ans: The crystalline substance, containing chemically combined H_2O in definite proportions is called hydrate.

Examples

$H_2C_2O_4 . xH_2O$ (Oxalic acid) $Na_2CO_3 . 10H_2O$

3. How hydrates are prepared?

Ans: Hydrates are prepared by evaporating their aqueous solutions.

4. What is the basicity of oxalic acid

Ans: Since oxalic acid has two ionizable hydrogen atoms, so it is a dibasic acid. Its basicity is **2**.

5. How many water of crystallization are present in oxalic acid?

Ans: The formula of oxalic acid is $H_2C_2O_4 . xH_2O$. So, it has two water of crystallization.

6. What is the purpose of determining the value of 'x' by volumetric method in a sample of oxalic acid?

Ans: The purpose is to determine the molar ratio of oxalic acid to water in a given sample, represented by the variable 'x', using volumetric analysis

7. What indicator is commonly used in the titration of oxalic acid with a base, and why?

Ans: Phenolphthalein is commonly used as an indicator because it changes color sharply at the endpoint of the titration, which corresponds to the neutralization of oxalic acid.

8. How will you prepare 500 cm^3 of 0.05 M oxalic acid [$H_2C_2O_4 . 2H_2O$] solution?

Ans:

Mass of $H_2C_2O_4 . xH_2O$ $= m = ?$

Molar mass of $H_2C_2O_4 . xH_2O$ $= M = 12\times2+16\times4+1\times2+2\times18 = 126\ g\ mol^{-1}$

Volume of solution $= V = 500\ cm^3 = \frac{500}{1000}\ dm^3 = 0.5\ dm^3$

Molarity $= 0.05\ M$

So, $$\text{Molarity} = \frac{m}{M} \times \frac{1}{V}$$

or $$m = \text{Molarity} \times M \times V$$
$$= 0.05 \times 126 \times 0.5$$
$$= 3.15\ g$$

Thus 3.15 g of $H_2C_2O_4.2H_2O$ are taken in a 500 cm^3 flask and the volume of solution is made upto the mark (i.e. 500 cm^3) with distilled water.

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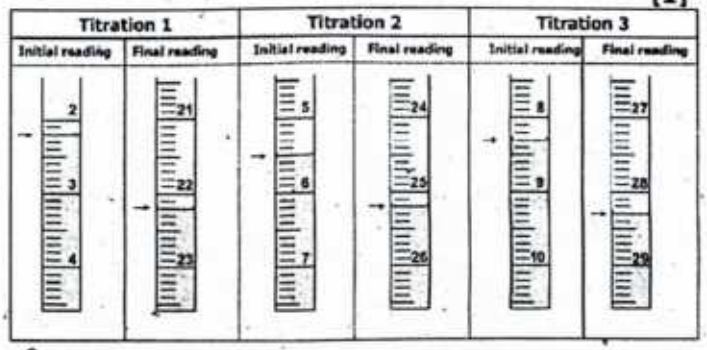
PRACTICAL BASED ASSESSMENT (PBA) TEST-1 Marks 06

Q. A 1.575 g sample of hydrated oxalic acid, $(COOH)_2 \cdot xH_2O$, was dissolved in water and the solution made up to 500 cm³. A 10.0 cm³ sample of 0.10 M sodium hydroxide solution was measured into a titration flask, and the oxalic acid solution was run from the burette into the flask until the end-point was reached. Phenolphthalein was used as an indicator.

(a) When oxalic acid solution was added from the burette into the flask containing the NaOH solution, What was the colour change observed at the end-point? [1]

(b) See on the figure given below and record the observations in table. Identify the best titration results, and determine the average volume of oxalic acid used. [1]



Observation Table:

Titration number	1	2	3
Final Reading (cm^3)			
First Reading (cm^3)			
Volume of $H_2C_2O_4 \cdot xH_2O$ used (cm^3)			
Best titration result (✓)			

From best titration result,
the average volume of $H_2C_2O_4 \cdot xH_2O$ used = _____ cm^3

(c) Write equation of the reaction and calculate the molarity of oxalic acid solution. [2]

(d) Given that 1.575 g of $(COOH)_2 \cdot xH_2O$ was dissolved per 500 cm³ of solution, calculate the value of x in $(COOH)_2 \cdot xH_2O$. *[H= 1, O= 16 , C= 12]* [2]

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PRACTICAL BASED ASSESSMENT (PBA) TEST-2 Marks 06

Q. No. 1: A *sample of* hydrated oxalic acid, $(COOH)_2 \cdot xH_2O$, weighing 1.26 g was dissolved in distilled water and the solution made up to 200 cm^3. A 10 cm^3 portion of 0.15 M sodium hydroxide solution was pipetted into a clean conical flask. The oxalic acid solution was added from a burette using phenolphthalein as indicator until the end-point.

(a) Write balanced equation for the reaction. **[1]**

(b) The student performs three titrations. The volumes of oxalic acid solution used were 14.8, 14.6 cm^3 and 14.2 cm^3, respectively. Of these, use best results and calculate the average volume of oxalic acid solution used. **[1]**

(c) Calculate the molarity of the oxalic acid solution (H=1, C=12, O=16). **[2]**

(d) Given that 1.26 g of $(COOH)_2.xH_2O$ was dissolved to make 200 cm^3, calculate the value of x (number of waters of crystallization). Show full working and give x to the nearest whole number. **[2]**

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SOLUTION PRACTICAL BASED ASSESSMENT (PBA) TEST-1 Marks 06

(a) Since phenolphthalein is used as an indicator so at the endpoint the colour changes from pink to very light pink almost colourless.

(b) Observation Table:

Titration number	1	2	3
Final Reading (cm^3)	22.2	25.2	28.3
First Reading (cm^3)	2.2	5.5	8.3
Volume of $H_2C_2O_4 . xH_2O$ used (cm^3)	19.9	19.5	20.1
Best titration result (✓)	✓		✓

From best titration result, the average volume of $H_2C_2O_4 . xH_2O$ used = 20.0 cm^3

(c) The chemical equations is:

$$2NaOH + \begin{matrix}COOH\\|\\COOH\end{matrix} \cdot xH_2O \rightarrow \begin{matrix}COONa\\|\\COONa\end{matrix} + (x+2)\,H_2O$$

The molarity of oxalic acid is calculated as:

$$\underset{M_1\ V_1}{\mathbf{H_2C_2O_4 . xH_2O}} \quad \underset{M_2\ V_2}{\mathbf{NaOH}}$$

$$\frac{M_1 V_1}{n_1} = \frac{M_2 V_2}{n_2}$$

$$M_1 = \frac{M_2 V_2}{n_2} \times \frac{n_1}{V_1}$$

$$M_1 = \frac{0.10 \times 10.0}{2} \times \frac{1}{20.0} = 0.025\ M$$

(d) Since, 1.575 g oxalic acid is dissolved in 500 cm^3, therefore,

500 cm^3 solution contains oxalic acid = 1.575 g

1 cm^3 solution contains oxalic acid = $\frac{1.575}{500}$ g

1000 cm^3 solution contains oxalic acid = $\frac{1.575}{500} \times 1000 = 3.15$ g

Molar mass of $H_2C_2O_4 . xH_2O$ = $12 \times 2 + 16 \times 4 + 1 \times 2 + 18x$

= $90 + 18x$

Mass of $H_2C_2O_4 . xH_2O$ per dm^3 = Molarity (M_1) × Molar mass of $H_2C_2O_4 . xH_2O$

$3.15 = 0.025 \times (90 + 18x)$

$90 + 18x = \frac{3.15}{0.025}$

$18x = 126 - 90$

$x = \frac{36}{18} = 2$

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SOLUTION PRACTICAL BASED ASSESSMENT (PBA) TEST-2 Marks 06

(a) The chemical equations is:

$$2NaOH + \begin{matrix}COOH\\|\\COOH\end{matrix} \cdot xH_2O \rightarrow \begin{matrix}COONa\\|\\COONa\end{matrix} + (x+2)\,H_2O$$

(b) From concordant titration result, the average volume of $H_2C_2O_4 . xH_2O$ used $= \frac{14.6+14.8}{2} = 14.7\ cm^3$

(c) The molarity of oxalic acid is calculated as:

$$\underset{M_1\ V_1}{\underset{n_1}{H_2C_2O_4 . xH_2O}} = \underset{M_2\ V_2}{\underset{n_2}{NaOH}}$$

$$M_1 = \frac{M_2\ V_2}{n_2} \times \frac{n_1}{V_1}$$

$$M_1 = \frac{0.15 \times 10}{2} \times \frac{1}{14.7} = 0.051\ M$$

(d) Since, 1.26 g oxalic acid is dissolved in 200 cm^3, therefore,

200 cm^3 solution contains oxalic acid $= 1.26$ g

1 cm^3 solution contains oxalic acid $= \frac{1.26}{200}$ g

1000 cm^3 solution contains oxalic acid $= \frac{1.26}{200} \times 1000 = 6.3$ g

Molar mass of $H_2C_2O_4 . xH_2O = 12 \times 2 + 16 \times 4 + 1 \times 2 + 18x$

$= 90 + 18x$

Mass of $H_2C_2O_4 . xH_2O$ per dm^3 = Molarity (M_1) × Molar mass of $H_2C_2O_4 . xH_2O$

$6.3 = 0.051 \times (90 + 18x)$

$90 + 18x = \frac{6.3}{0.051}$

$90 + 18x = 123.5$

$18x = 123.5 - 90$

$18x = 33.5$

$x = \frac{33.5}{18} = 1.86 \approx 2$

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REDOX TITRATIONS

04 EXPERIMENT

Standardize the given solution of $KMnO_4$ by using compound of Iron(II) and calculate the volume of $KMnO_4$ required for preparing 1dm³ of 0.01M $KMnO_4$ solution volumetrically

Apparatus used: Burette, pipette, funnel, conical flask, beakers, iron stand.

Chemicals used: Distilled water, H_2SO_4 Solution, Standard solution of Mohr's salt, 0.1 M

Chemical Equation:

$$2KMnO_4 + 3H_2SO_4 \rightarrow K_2SO_4 + 2MnSO_4 + 3H_2O + 5[O]$$

$$[2FeSO_4.(NH_4)_2SO_4.6H_2O + H_2SO_4 + [O] \rightarrow Fe_2(SO_4)_3 + 2(NH_4)_2SO_4 + 13H_2O] \times 5$$

Overall Reaction

$$2KMnO_4 + 10FeSO_4.(NH_4)_2SO_4.6H_2O + 8H_2SO_4 \rightarrow K_2SO_4 + 2MnSO_4 + 5Fe_2(SO_4)_3 + 10(NH_4)_2SO_4 + 68H_2O$$

Standard Solution: 0.10 M Mohr's salt solution

Mole Ratio from balanced equation:

$KMnO_4$ solution : Mohr's salt

2 : 10

Indicator used: $KMnO_4$ itself acts as indicator

End Point: Light pink colour appears

Procedure:

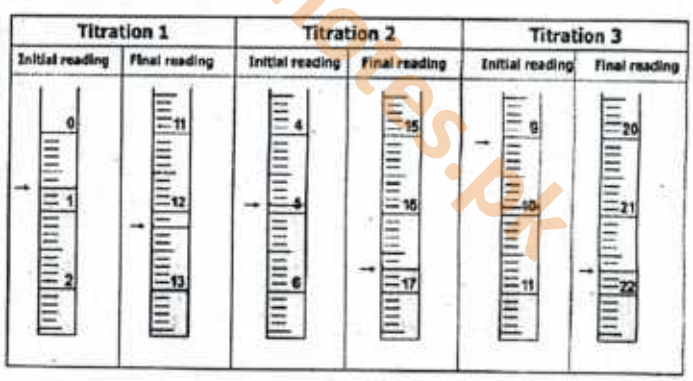
- Fill burette with $KMnO_4$ solution,
- Pipette out 10.0 cm³ Mohr's salt solution and pour into a conical flask.
- Add 10.0 cm³ H_2SO_4 solution to conical flask.
- Titrate Mohr's salt solution with $KMnO_4$ solution till the end point is reached

Instructions:

Repeat the titration as many time as you think necessary to obtain accurate results.
Make certain that the recorded results show the accuracy of your practical work.

Observation Table:

Titration number	1	2	3
Final Reading (cm³)	12.2	16.7	21.7
First Reading (cm³)	0.7	4.9	9.9
Volume of $KMnO_4$ used (cm³)	11.5	11.8	11.8
Best titration result (✓)		✓	✓



From best titration result,
the average volume of $KMnO_4$ used = 11.8 cm³

Calculations:

(a) Data for given titration

M_1 = Molarity of $KMnO_4$ = ?
M_2 = Molarity of Mohr's salt = 0.1 M
V_1 = Volume of $KMnO_4$ solution used = 11.8 cm³
V_2 = Volume of Mohr's salt solution used = 10.0 cm³
n_1 = Number of moles of $KMnO_4$ in balanced equation = 2
n_2 = Number of moles of Mohr's salt in balanced equation = 10

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(b) Calculate molarity of $KMnO_4$ using the formula $\frac{M_1 V_1}{n_1} = \frac{M_2 V_2}{n_2}$

The molarity of the $KMnO_4$ solution under test is determined with the help of the following equation:

$KMnO_4$ Mohr's salt

$$\frac{M_1 V_1}{n_1} = \frac{M_2 V_2}{n_2}$$

$$M_1 = \frac{M_2 V_2}{n_2} \times \frac{n_1}{V_1} = \frac{0.1 \times 10.0}{10} \times \frac{2}{11.8} = 0.0170 \text{ M}$$

(c) By using dilution formula prepare 1 dm^3 (1000 cm^3) of 0.01 M $KMnO_4$ solution

Given concentration in "b" = Required concentration

$$M_1V_1 = M_2V_2$$

$$0.0170 \times V_1 = 0.010 \times 1000$$

$$V_1 = \frac{0.010 \times 1000}{0.0170} = 588 \text{ cm}^3$$

(d) Brief explanation to make 0.01M $KMnO_4$ solution

Measure 588 cm^3 volume by measuring cylinder from 0.017 M $KMnO_4$ solution. Pour into 1 dm^3 volumetric flask and make up, up to the mark by water.

Result: Resulting solution will be 0.01 M $KMnO_4$ solution.

VIVA VOCE

1. What is the formula of Mohr's salt?

Ans: $FeSO_4.(NH_4)_2SO_4.6H_2O$

2. Why $KMnO_4$ itself acts as an indicator?

Ans: It is because, its solution is purple in color and even a small amount of $KMnO_4$ gives a very dark color to a solution. Thus it becomes easy to tell endpoint of titration.

3. What is the oxidation state of Mn in $KMnO_4$?

Ans: +7

4. Why dilute sulphuric acid is used in $KMnO_4$ titration?

Ans: It has two funcitons

(i) It provides excess H^+ ions in solution which allow the reaction to continue

(ii) It prevents the formation of manganese dioxide

5. The molarity of a given $KMnO_4$ solution is 0.01 M. Calculate the mass of Mn per dm^3 of solution. [Mn=55]

Ans: Atomic mass of Mn = 55 g mol^{-1}

Mass of Mn per dm^3 = Molarity × Atomic mass of Mn

= 0.01 × 55 = 0.55 g dm^{-3}

Define oxidation and reduction?

Ans: Oxidation is defined as the addition of oxygen, loss of hydrogen or loss of electrons from a species

Reduction is defined as the removal of oxygen, addition of hydrogen or addition of electrons from a species.

6. What are redox reactions?

Ans: A redox reaction involves the transfer of electrons between different species.

Example: Consider the reaction $Zn + Cu^{2+} \rightarrow Zn^{2+} + Cu$

In this reaction, Zn is oxidized as Zn loses two electrons to form Zn^{2+} ions.

In this reaction, Cu^{2+} is reduced as Cu^{2+} gains two electrons to form Cu.

7. The molarity of given $KMnO_4$ solution is 0.01 M. Calculate the mass of $KMnO_4$ in 500 cm^3 of solution. [K= 39, Mn= 55 , O = 16]

Ans: Molar mass of $KMnO_4 = 39 \times 1 + 55 \times 1 + 16 \times 4 = 158$ g mol^{-1}

Mass of $KMnO_4$ per dm^3 = Molarity × Molar mass of $KMnO_4$

= 0.01 × 158 = 1.58 g dm^{-3}

Since 1 dm^3 = 1000 cm^3,

So, 1000 cm^3 solution contains $KMnO_4$ = 1.58 g

1 cm^3 solution contains $KMnO_4$ = $\frac{1.58}{1000}$ g

500 cm^3 solution contains $KMnO_4$ = $\frac{1.58}{1000} \times 500 = 0.79$ g

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PRACTICAL BASED ASSESSMENT (PBA) TEST Marks 06

Q. A potassium manganate(VII) solution (Solution A) was supplied of unknown concentration. It was standardized volumetrically using Mohr's salt which is iron(II) ammonium sulfate, $Fe(NH_4)_2(SO_4)_2{\cdot}6H_2O$ (Solution B) of known concentration 0.10 M. The overall reaction is

$$2KMnO_4 + 10FeSO_4.(NH_4)_2SO_4.6H_2O + 8H_2SO_4 \rightarrow K_2SO_4 + 2MnSO_4 + 5Fe_2(SO_4)_3 + 10(NH_4)_2SO_4 + 68H_2O$$

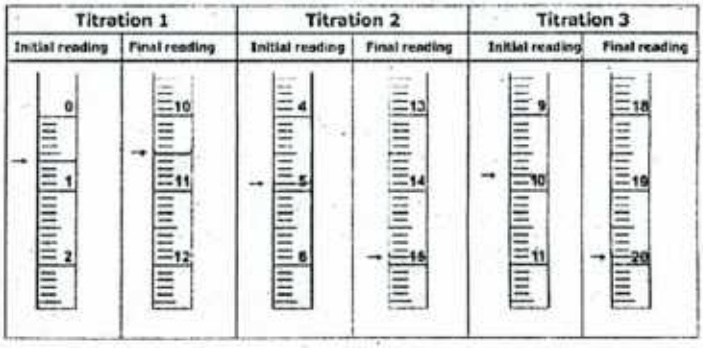
(a) Which indicator is used? What is the color change at the endpoint? **[1]**

(b) See on the figure given below and record the observations in table **[2]**

Observation Table:

Titration number	1	2	3
Final Reading (cm^3)			
First Reading (cm^3)			
Volume of $KMnO_4$ used (cm^3)			
Best titration result (✓)			

From best titration result,
the average volume of $KMnO_4$ used = _____ cm^3



(c) Using the given titration data and the balanced equation, calculate the molarity of the original $KMnO_4$ solution (Solution A). **[2]**

(d) Using your answer to (c), determine the volume of Solution A required to prepare 500 cm^3 of 0.01 M $KMnO_4$ solution. **[1]**

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SOLUTION PRACTICAL BASED ASSESSMENT (PBA) TEST Marks 06

(a) $KMnO_4$ *itself acts as an indicator. The colour changes to light pink which is the endpoint*

(b) Observation Table

Titration number	1	2	3
Final Reading (cm^3)	10.5	14.9	19.9
First Reading (cm^3)	0.6	4.9	9.8
Volume of $KMnO_4$ used (cm^3)	9.9	10.0	10.1
Best titration result (✓)	✓	✓	✓

From best titration result, the average volume of $KMnO_4$ used = 10.0 cm^3

(c) **$KMnO_4$ = Mohr's Salt**

$$\frac{M_1 V_1}{n_1} = \frac{M_2 V_2}{n_2}$$

$$M_1 = \frac{M_2 V_2}{n_2} \times \frac{n_1}{V_1}$$

$$M_1 = \frac{0.10 \times 10.0}{10} \times \frac{2}{10.0} = 0.020\ M$$

(d) Given concentration in "b" = Required concentration

$$M_1V_1 = M_2V_2$$

$$0.020 \times V_1 = 0.010 \times 500$$

$$V_1 = \frac{0.01 \times 500}{0.020} = 250\ cm^3$$

Measure 250 cm^3 volume by measuring cylinder from 0.02 M $KMnO_4$ solution. Pour into 1 dm^3 volumetric flask and make up, upto the mark by water.

Experiment 4-A

Standardize the Given Solution of $KMnO_4$ and calculate the volume of $KMnO_4$ required for preparing 500 cm^3 of 0.0100M $KMnO_4$ solution volumetrically

Apparatus used: Burette, pipette, funnel, conical flask, beakers, iron stand.

Chemicals used: $KMnO_4$ solution, Distilled water, H_2SO_4 Solution, Standard solution of $FeSO_4.7H_2O$, 0.100 M

Chemical Equation:

$$2KMnO_4 + 3H_2SO_4 \rightarrow K_2SO_4 + 2MnSO_4 + 3H_2O + 5[O]$$

$$[2FeSO_4.7H_2O + H_2SO_4 + [O] \rightarrow Fe_2(SO_4)_3 + 15H_2O] \times 5$$

Overall Reaction

$$2KMnO_4 + 8H_2SO_4 + 10FeSO_4.7H_2O \rightarrow K_2SO_4 + 5Fe_2(SO_4)_3 + 2MnSO_4 + 78H_2O$$

Standard Solution:
0.100 M $FeSO_4.7H_2O$

Mole Ratio from balanced equation:

$KMnO_4$	:	$FeSO_4.7H_2O$
2	:	10

Indicator used:
$KMnO_4$ itself acts as indicator

End Point: Light pink colour is appeared

NOTE:
- Burette reading up to two decimal places **(2 d.p.)** and average value with three significant figures **(3 s.f.)**. Pipette reading with **3 s.f.**
- Molarity of standard solution is given with **3 s.f.**
- *Since, least number of **s.f.** in given data is **3**, so all results will be expressed with **3 s.f.***

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Procedure:

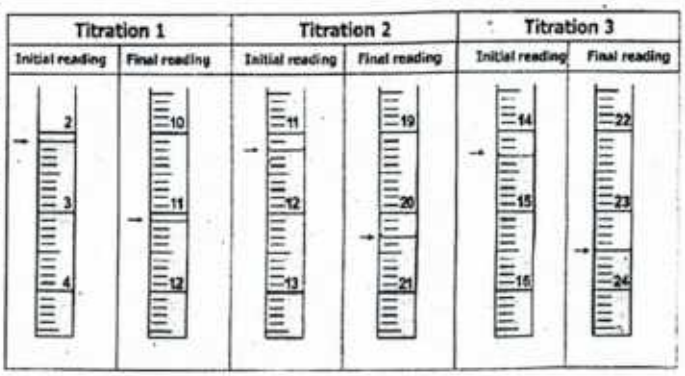
- Fill burette with $KMnO_4$ solution,
- Pipette out 10.0 cm^3 $FeSO_4.7H_2O$ solution and pour into a conical flask.
- Add 10.0 cm^3 H_2SO_4 solution to conical flask.
- Titrate $FeSO_4.7H_2O$ solution with $KMnO_4$ solution till the end point is reached

Instructions:

Repeat the titration as many time as you think necessary to obtain accurate results.
Make certain that the recorded results show the accuracy of your practical work.

Observation Table:

Titration number	1	2	3
Final Reading (cm^3)	11.10	20.30	23.50
First Reading (cm^3)	2.10	11.20	14.30
Volume of $KMnO_4$ used (cm^3)	9.00	9.10	9.20
Best titration result (✓)	✓	✓	✓



From best titration result,
the average volume of $KMnO_4$ used = 9.10 cm^3 **3 s.f.**

Calculations:

(a) Data for given titration

M_1 = Molarity of $KMnO_4$ = ?
M_2 = Molarity of $FeSO_4.7H_2O$ = 0.100 M **3 s.f.**
V_1 = Volume of $KMnO_4$ solution used = 9.10 cm^3 **3 s.f.**
V_2 = Volume of $FeSO_4.7H_2O$ solution used = 10.0 cm^3 **3 s.f.**
n_1 = Number of moles of $KMnO_4$ in balanced equation = 2
n_2 = Number of moles of $FeSO_4.7H_2O$ in balanced equation = 10

(b) Calculate molarity of $KMnO_4$ using the formula $\frac{M_1 V_1}{n_1} = \frac{M_2 V_2}{n_2}$

The molarity of the $KMnO_4$ solution under test is determined with the help of the following equation:

$$\underset{\frac{M_1 V_1}{n_1}}{\mathbf{KMnO_4}} = \underset{\frac{M_2 V_2}{n_2}}{\mathbf{FeSO_4.7H_2O}}$$

$$M_1 = \frac{M_2 V_2}{n_2} \times \frac{n_1}{V_1}$$

$$M_1 = \frac{0.100 \times 10.0}{10} \times \frac{2}{9.10}$$

$$M_1 = 0.0220\ M \quad \boxed{3\ s.f.}$$

(c) By using dilution formula prepare 500 cm^3 of 0.0100 M $KMnO_4$ solution

Given concentration in "b" = Required concentration

$$M_1V_1 = M_2V_2$$

$$0.0220 \times V_1 = 0.0100 \times 500.0$$

$$V_1 = \frac{0.0100 \times 500.0}{0.0220} = 227\ cm^3 \quad \boxed{3\ s.f.}$$

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(d) Brief explanation to make 0.0100M $KMnO_4$ solution

Measure 227 cm^3 volume by measuring cylinder from 0.0220 M $KMnO_4$ solution. Pour into 1 dm^3 volumetric flask and make up, upto the mark by water.

Result: Resulting solution will be 0.01 M $KMnO_4$ solution.

VIVA VOCE

1. Identify oxidizing and reducing agents in the reaction

$$2KMnO_4 + 8H_2SO_4 + 10FeSO_4.7H_2O \rightarrow K_2SO_4 + 2MnSO_4 + 78H_2O + 5Fe_2(SO_4)_3$$

Ans: In this reaction,

- $KMnO_4$ acts as an oxidizing agent. It oxidizes Fe^{2+} (Ferrous) in $FeSO_4$ to Fe^{3+} (Ferric) in $Fe_2(SO_4)_3$
- $FeSO_4.7H_2O$ is reducing agent. It reduces manganese is reduced from +7 oxidation state in $KMnO_4$ to +2 oxidation state in $MnSO_4$.

2. The molarity of a given $FeSO_4.7H_2O$ solution is 0.050 M. Calculate the mass of Fe (iron) per dm^3 of solution. [Fe= 56]

Ans: Atomic mass of Fe = 56 g mol^{-1}

Mass of Fe per dm^3 = Molarity × Atomic mass of Fe

= 0.050 × 56

= 2.8 g dm^{-3}

3. What is the type of reaction between $KMnO_4$ and $FeSO_4.7H_2O$?

Ans: It is a reduction-oxidation reaction or redox reaction.

4. Explain why no external indicator is used in for the titration of $KMnO_4$ and $FeSO_4.7H_2O$?

Ans: $KMnO_4$ is a coloured substance. So, it itself acts as an indicator.

5. Identify which elements are oxidized and reduced in the reaction

$$2KMnO_4 + 8H_2SO_4 + 10FeSO_4.7H_2O \rightarrow K_2SO_4 + 2MnSO_4 + 78H_2O + 5Fe_2(SO_4)_3$$

Ans: In this reaction,

- Iron is oxidized from Fe^{2+} (Ferrous) in $FeSO_4$ to Fe^{3+} (Ferric) in $Fe_2(SO_4)_3$
- Manganese is reduced from +7 oxidation state in $KMnO_4$ to +2 oxidation state in $MnSO_4$

6. What is an oxidizing agent?

Ans: It accepts electrons from other substances. So, itself is reduced and oxidizes other substances.

e.g., In the reaction.

$$2KMnO_4 + 8H_2SO_4 + 10FeSO_4.7H_2O \rightarrow K_2SO_4 + 2MnSO_4 + 78H_2O + 5Fe_2(SO_4)_3$$

The Mn in **$KMnO_4$** accepts electron from Fe^{2+} in $FeSO_4$ and oxidizes it to Fe^{3+} in $Fe_2(SO_4)_3$, So, $KMnO_4$ is an oxidizing agent. Other examples $K_2Cr_2O_7$, I_2 etc

7. What is a reducing agent?

Ans: It gives electrons to other substance. So, itself is oxidized and reduces other substances.

e.g., In the reaction

$$2KMnO_4 + 8H_2SO_4 + 10FeSO_4.7H_2O \rightarrow K_2SO_4 + 2MnSO_4 + 78H_2O + 5Fe_2(SO_4)_3$$

The Fe^{2+} in $FeSO_4$ gives electron to Mn in $KMnO_4$ which is reduced from +7 oxidation state in $KMnO_4$ to +2 oxidation state in $MnSO_4$. So, $FeSO_4$ is the reducing agent. Other examples H_2S , HI etc

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PRACTICAL BASED ASSESSMENT (PBA) TEST-1 Marks 06

Q. A potassium manganate(VII) solution (Solution A) was standardized by titration with a standard iron(II) sulfate heptahydrate ($FeSO_4 \cdot 7H_2O$) solution containing 13.92 g dm^{-3}. After standardization, Solution A was diluted to prepare 250 cm^3 of 0.0100 mol dm^{-3} $KMnO_4$ solution.

(a) Write the balanced equation for reaction between $KMnO_4$ and $FeSO_4$ in acidic medium. and state what is the type of this reaction. **[1]**

(b) Determine the molarity of $FeSO_4.7H_2O$ solution? [Fe=56, S=32, O=16, H=1] **[2]**

(c) In the titration, 20.0 cm^3 of $FeSO_4 \cdot 7H_2O$ solution required 10.0 cm^3 of Solution A for complete reaction. Determine the molarity of Solution A ($KMnO_4$). **[2]**

(d) Calculate the volume (in cm^3) of the original standardized $KMnO_4$ solution that must be diluted to 250 cm^3 in order to obtain a 0.0100 mol dm^{-3} solution. **[1]**

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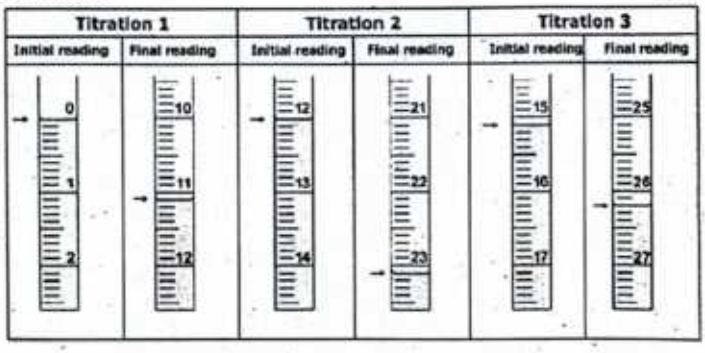
PRACTICAL BASED ASSESSMENT (PBA) TEST-2 Marks 06

Q. A solution was prepared by dissolving $FeSO_4 \cdot 7H_2O$ in water and making the volume up to 500 cm^3. A 10.0 cm^3 of this solution was titrated with 0.02 mol dm^{-3} $KMnO_4$ solution acidified with dilute H_2SO_4.

(a) Explain why no external indicator is used in this titration and describe the colour change at the end-point. **[1]**

(b) See on the figure given below and record the observations in table **[2]**



Observation Table:

Titration number	1	2	3
Final Reading (cm^3)			
First Reading (cm^3)			
Volume of $KMnO_4$ used (cm^3)			
Best titration result (✓)			

From best titration result,
the average volume of $KMnO_4$ used = _____ cm^3

(c) Determine the mole ratio from balanced chemical equation and calculate the molarity of $FeSO_4.7H_2O$ using the formula. **[2]**

(d) Calculate the mass of $FeSO_4.7H_2O$, per dm^3 and per 300 cm^3. *[Fe= 56, O= 16, S= 32, H=1]* **[1]**

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SOLUTION PRACTICAL BASED ASSESSMENT (PBA) TEST-1 Marks 06

(a) $2KMnO_4 + 8H_2SO_4 + 10FeSO_4.7H_2O \rightarrow K_2SO_4 + 5Fe_2(SO_4)_3 + 2MnSO_4 + 78H_2O$

This is a redox reaction. $KMnO_4$ acts as oxidizing agent and $FeSO_4.7H_2O$ acts as reduction agent.

(b) Molar mass of $FeSO_4.7H_2O = 56+32+16\times4+18\times7=278$ g mol^{-1}

Since the solution contains 13.92 g dm^{-3}

Thus,

$$\text{Molarity of } FeSO_4.7H_2O \text{ solution} = \frac{13.92}{278} = 0.0501 \text{ mol dm}^{-3}$$

(c) $KMnO_4$ $FeSO_4.7H_2O$

$$\frac{M_1 V_1}{n_1} = \frac{M_2 V_2}{n_2}$$

$$M_1 = \frac{M_2 V_2}{n_2} \times \frac{n_1}{V_1}$$

$$M_1 = \frac{0.0501 \times 20.0}{10} \times \frac{2}{10.0} = 0.0200 \text{ M}$$

(d) By using dilution formula prepare the 0.0100 M $KMnO_4$ solution

Given concentration in "b" = Required concentration

$$M_1V_1 = M_2V_2$$

$$0.0200 \times V_1 = 0.0100 \times 250$$

$$V_1 = \frac{0.0100 \times 250}{0.02}$$

$$= 125 \text{ cm}^3$$

Measure 125 cm^3 volume by measuring cylinder from 0.0200 M $KMnO_4$ solution. Pour into 250 cm^3 volumetric flask and make up, up to the mark by water.

SOLUTION PRACTICAL BASED ASSESSMENT (PBA) TEST-2 Marks 06

(a) $KMnO_4$ is a coloured substance. So, it itself acts as an indicator. The colour changes to light pink which is the endpoint

(b) Observation Table:

Titration number	1	2	3
Final Reading (cm^3)	11.1	23.1	26.2
First Reading (cm^3)	0.0	12.0	15.1
Volume of $KMnO_4$ used (cm^3)	11.1	11.1	11.1
Best titration result (✓)	✓	✓	✓

From best titration result,

the average volume of $KMnO_4$ used = 11.1 cm^3

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(c) The chemical euaiton is

$$2KMnO_4 + 8H_2SO_4 + 10FeSO_4.7H_2O \rightarrow K_2SO_4 + 5Fe_2(SO_4)_3 + 2MnSO_4 + 78H_2O$$

So, the mole ratio is $n_2 = 2$ $n_1 = 10$

The molarity of $FeSO_4.7H_2O$ is:

$$\underset{\frac{M_1 V_1}{n_1}}{\mathbf{FeSO_4.7H_2O}} = \underset{\frac{M_2 V_2}{n_2}}{\mathbf{KMnO_4}}$$

$$M_1 = \frac{M_2 V_2}{n_2} \times \frac{n_1}{V_1}$$

$$M_1 = \frac{0.02 \times 11.1}{2} \times \frac{10}{10.0}$$

$$= 0.111 \text{ M}$$

(d) The mass of $FeSO_4.7H_2O$ per dm^3

Molar mass of $FeSO_4.7H_2O = 56 \times 1 + 32 \times 1 + 16 \times 4 + 18 \times 7 = 278 \text{ g mol}^{-1}$

Mass of $FeSO_4.7H_2O$ per dm^3 = Molarity (M_2) × Molar mass of $FeSO_4.7H_2O$

$= 0.111 \times 278 = 30.9 \text{ g}$

The mass of $FeSO_4.7H_2O$ per 300 cm^3

1000 cm^3 solution contains $FeSO_4.7H_2O$ = 30.9 g

1 cm^3 solution contains $FeSO_4.7H_2O$ = $\frac{30.9}{1000}$ g

300 cm^3 solution contains $FeSO_4.7H_2O$ = $\frac{30.9}{1000} \times 300 = 9.27$ g

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Experiment 4-B

Determine the value of 'x' in $FeSO_4.xH_2O$ using redox titration with acidified $KMnO_4$ for which 27.8g of a given sample of $FeSO_4.xH_2O$ is dissolved per dm^3 of solution

Apparatus used:
Burette, pipette, funnel, conical flask, beakers, iron stand.

Chemicals used:
0.2 M $KMnO_4$ solution, Distilled water, H_2SO_4 Solution, Standard solution of $FeSO_4.xH_2O$

Chemical Equation:

$$2KMnO_4 + 8H_2SO_4 + 10FeSO_4.xH_2O \rightarrow K_2SO_4 + 5Fe_2(SO_4)_3 + 2MnSO_4 + (10x+8)\,H_2O$$

Standard Solution:
0.2 M $KMnO_4$

Mole Ratio from balanced equation:

$KMnO_4$	:	$FeSO_4.xH_2O$
2	:	10

NOTE:
- Burette reading up to one decimal place **(1 d.p.)** and average value with three significant figures **(3 s.f.)**. Pipette reading with **3 s.f.**
- Molarity of standard solution is defined as 0.2 M. This will be treated as exact and does not limit **s.f.**

Indicator used:
$KMnO_4$ itself acts as indicator

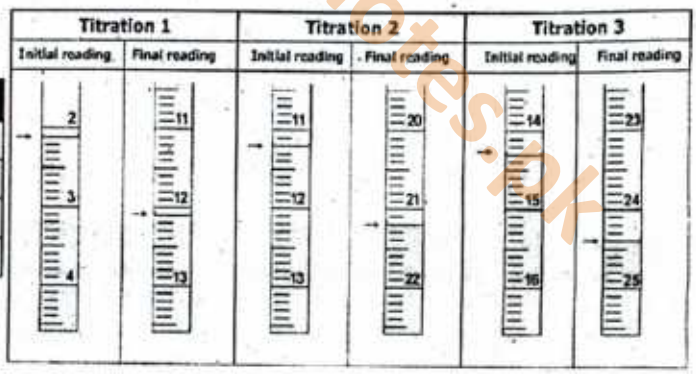
End Point:
Light pink colour is appeared

Procedure:
- Fill burette with $KMnO_4$ solution,
- Dissolve 27.8 g $FeSO_4.xH_2O$ per dm^3 of solution.
- Pipette out 10.0 cm^3 $FeSO_4.xH_2O$ solution and pour into a conical flask.
- Add 10cm^3 H_2SO_4 solution to conical flask.
- Titrate $FeSO_4.xH_2O$ solution with $KMnO_4$ solution till the end point is reached

Instructions:
Repeat the titration as many time as you think necessary to obtain accurate results.
Make certain that the recorded results show the accuracy of your practical work.

Observation Table:

Titration number	1	2	3
Final Reading (cm^3)	12.1	21.2	24.4
First Reading (cm^3)	2.1	11.2	14.3
Volume of $KMnO_4$ used (cm^3)	10.2	10.0	10.1
Best titration result (✓)	✓	✓	✓



From best titration result,
the average volume of $KMnO_4$ used = 10.1 cm^3

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Calculations:

(e) Data for given titration

M_1 = Molarity of $FeSO_4.xH_2O$ = ?
M_2 = Molarity of $KMnO_4$ = 0.2 M
V_1 = Volume of $FeSO_4.xH_2O$ solution used = 10.0 cm^3
V_2 = Volume of $KMnO_4$ solution used = 10.1 cm^3
n_1 = Number of moles of $FeSO_4.xH_2O$ in balanced equation = 10
n_2 = Number of moles of $KMnO_4$ in balanced equation = 2

(f) Calculate molarity of $KMnO_4$ using the formula $\frac{M_1 V_1}{n_1} = \frac{M_2 V_2}{n_2}$

$FeSO_4.7H_2O$ **$KMnO_4$**

$$\frac{M_1 V_1}{n_1} = \frac{M_2 V_2}{n_2}$$

$$M_1 = \frac{M_2 V_2}{n_2} \times \frac{n_1}{V_1}$$

$$M_1 = \frac{0.2 \times 10.1}{2} \times \frac{10}{10.0}$$

$$M_1 = 0.1 \text{ M}$$

Given mass of $FeSO_4.xH_2O$ dissolved per dm^3 = 27.8 g
Molar mass of $FeSO_4.xH_2O$ = 56+32+16 × 4 + 18x
= 152 + 18x

Mass of $FeSO_4.xH_2O$ per dm^3 = Molarity (M_2) × Molar mass of $FeSO_4.xH_2O$

$$27.8 = 0.1 \times (152 + 18x)$$

$$152 + 18x = \frac{27.8}{0.1}$$

$$152 + 18x = 278$$

$$18x = 278 - 152$$

$$18x = 126$$

$$x = \frac{126}{18} = 7$$

Result:

The value of 'x' in $FeSO_4.xH_2O$ = 7
Thus, there are seven molecules of water of crystallization.

PRACTICAL BASED ASSESSMENT (PBA) TEST Marks 06

Q. A student prepared a solution by dissolving 14 g of $FeSO_4 \cdot xH_2O$ in 500 cm^3 of distilled water. To find the value of x, a 0.0200 M potassium permanganate solution was used as the titrant.

(a) 25.0 cm^3 portion of the ferrous sulfate solution was placed in a conical flask. A small amount of concentrated sulfuric acid was added, and the solution was titrated with potassium permanganate until the reaction was complete. Name the indicate and write balanced equation for the reaction. **[1+1]**

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(b) The titration was performed carefully, and the most accurate volume of potassium permanganate solution required to reach the endpoint was 25.4 cm^3. Using this value, calculate the molarity of $FeSO_4 \cdot xH_2O$ solution. **[2]**

(c) By using your answer to (b), calculate the value of 'x' (water of crystallization) in $FeSO_4.xH_2O$. **[2]**

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SOLUTION PRACTICAL BASED ASSESSMENT (PBA) TEST Marks 06

(a) $KMnO_4$ itself acts as indicator and the endpoint is light pink.

$$2KMnO_4 + 10FeSO_4.xH_2O + 8H_2SO_4 \rightarrow K_2SO_4 + 2MnSO_4 + 5Fe_2(SO_4)_3 + (10x+8)H_2O$$

(b) $\quad$ **$FeSO_4.7H_2O$** $\quad$ **$KMnO_4$**

$$\frac{M_1 V_1}{n_1} = \frac{M_2 V_2}{n_2}$$

$$M_1 = \frac{M_2 V_2}{n_2} \times \frac{n_1}{V_1} = \frac{0.0200 \times 25.4}{2} \times \frac{10}{25.0} = 0.102 \text{ M}$$

(c) Given mass of $FeSO_4.xH_2O$ dissolved per dm^3 = 28 g

Molar mass of $FeSO_4.xH_2O$ $= 56+32+16 \times 4 + 18x$

$= 152 + 18x$

500 cm^3 solution contains $FeSO_4.xH_2O$ = 14 g

1 cm^3 solution contains $FeSO_4.xH_2O$ $= \frac{14}{500}$ g

1000 cm^3 solution contains $FeSO_4.xH_2O$ $= \frac{14}{500} \times 1000 = 28$ g

Mass of $FeSO_4.xH_2O$ per dm^3 = Molarity (M_2) × Molar mass of $FeSO_4.xH_2O$

$28 = 0.102 \times (152 + 18x)$

$$152 + 18x = \frac{28}{0.102}$$

$152 + 18x = 275$

$18x = 275 - 152$

$18x = 123$

$$x = \frac{123}{18} = 6.83 \approx 7$$

05 EXPERIMENT

Determine the strength of oxalic acid in 500cm³ of its solution by titrating it against a standard solution of Potassium manganate (VII), $KMnO_4$ in an acidic medium

Apparatus used:

Burette, pipette, funnel, conical flask, beakers, iron stand.

Chemicals used:

$H_2C_2O_4.xH_2O$ solution, Distilled water, H_2SO_4 Solution, Standard solution of $KMnO_4$, 0.02M

Chemical Equation:

$$2KMnO_4 + 3H_2SO_4 \rightarrow K_2SO_4 + 2MnSO_4 + 3H_2O + 5[O]$$

$$\left(\begin{matrix} COOH \\ | \\ COOH \end{matrix} \cdot xH_2O + [O] \rightarrow 2CO_2 + (x+1)\,H_2O \right) \times 5$$

Overall Reaction

$$2KMnO_4 + 3H_2SO_4 + 5 \begin{matrix} COOH \\ | \\ COOH \end{matrix} \cdot xH_2O \rightarrow K_2SO_4 + 2MnSO_4 + (5x+8)H_2O + 10CO_2$$

Standard Solution:

0.02 M $KMnO_4$ solution

Mole Ratio from balanced equation:

$KMnO_4$	:	$H_2C_2O_4.xH_2O$
2	:	5

Indicator used:

$KMnO_4$ itself acts as indicator

End Point:

Light pink colour appears

NOTE:

- Burette reading up to one decimal place **1 d.p.** and average value with three significant figures **3 s.f.** Pipette reading with **3 s.f.**
- Molarity of standard solution is defined as 0.02 M. This will be treated as exact and does not limit **s.f.**

Procedure:

- Fill burette with $KMnO_4$ solution,
- Pipette out 10.0 cm^3 oxalic acid solution and pour into a conical flask.
- Add 10.0 cm^3 H_2SO_4 solution to conical flask and heat.
- Titrate oxalic acid solution with $KMnO_4$ solution till the end point is reached

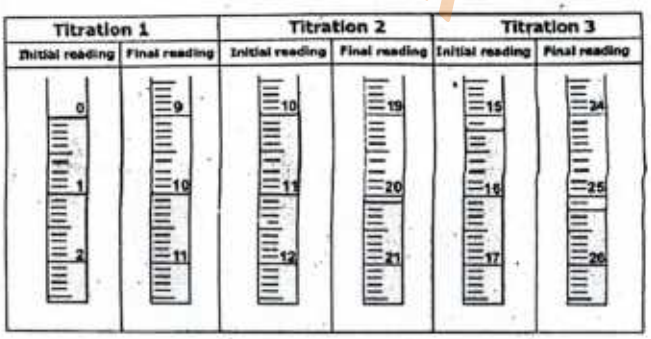
Instructions:

Repeat the titration as many time as you think necessary to obtain accurate results.
Make certain that the recorded results show the accuracy of your practical work.

Observation Table:

Titration number	1	2	3
Final Reading (cm^3)	10.0	20.1	25.2
First Reading (cm^3)	0.0	10.0	15.2
Volume of $KMnO_4$ used (cm^3)	10.0	10.1	10.0
Best titration result (✓)	✓		✓

From best titration result,
the average volume of $KMnO_4$ used = 10.0 cm^3



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Calculations:

(a) Data for given titration

M_1 = Molarity of oxalic acid solution = ? M
M_2 = Molarity of $KMnO_4$ solution = 0.02 M
V_1 = Volume of oxalic acid solution used = 10.0 cm^3
V_2 = Volume of $KMnO_4$ solution used = 10.0 cm^3
n_1 = Number of moles of $KMnO_4$ in balanced equation = 2
n_2 = Number of moles of oxalic acid in balanced equation = 5

(b) Calculation of molarity using the formula $\frac{M_1 V_1}{n_1} = \frac{M_2 V_2}{n_2}$

The molarity of the oxalic acid solution under test is determined with the help of the following equation:

Oxalic acid **$KMnO_4$**

$$\frac{M_1 V_1}{n_1} = \frac{M_2 V_2}{n_2}$$

$$M_1 = \frac{M_2 V_2}{n_2} \times \frac{n_1}{V_1}$$

$$M_1 = \frac{0.02 \times 10.0}{2} \times \frac{5}{10.0}$$

$$M_1 = 0.05 \text{ M}$$

(c) Calculate mass of oxalic acid per dm^3 from "b": ***[H= 1, O= 16 , C= 12]***

Molar mass of oxalic acid ($H_2C_2O_4.2H_2O$) = $1\times2 + 12\times2 + 16\times4+18\times2$
= 126 g mol^{-1}

Mass of oxalic acid per dm^3 = Molarity (M_2) × Molar mass of $H_2C_2O_4.xH_2O$
= 0.05 × 126
= 6.30 g dm^{-3}

The mass of oxalic acid per 500 cm^3

1000 cm^3 solution contains oxalic acid = 6.30 g

1 cm^3 solution contains oxalic acid = $\frac{6.30}{1000}$ g

500 cm^3 solution contains oxalic acid = $\frac{6.30}{1000} \times 500 = 3.15$ g

Result: The given solution contains 3.15 g oxalic acid in 500 cm^3 of solution.

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VIVA VOCE

1. What is redox titration?
Ans: It is the titration inwhich both reduction and oxidation reactions occur simultaneously.

2. What happens to oxalic acid during titration with $KMnO_4$?
Ans: Oxalic acid is oxidized by $KMnO_4$ to CO_2 and H_2O

3. Why oxalic acid and oxalates are heated before titration with $KMnO_4$?
Ans: The oxalic acid and oxalates solutions are heated to increase the rate of decarboxylation and to increase the rate of production of Mn^{2+} ions. Thus, reaction becomes speed up.

4. What is the role of oxalic acid in titration with $KMnO_4$?
Ans: Oxalic acid acts as reducing agent and reduces $KMnO_4$ to $MnSO_4$

5. What is the role of oxalic acid in titration with $KMnO_4$?
Ans: Oxalic acid acts as a reducing agent and reduces $KMnO_4$ to $MnSO_4$

6. Write the reaction between oxalic acid and $KMnO_4$ in the presence of dilute sulphuric acid.

$$2KMnO_4 + 8H_2SO_4 + 5H_2C_2O_4.2H_2O \rightarrow K_2SO_4 + 2MnSO_4 + 18H_2O + 10CO_2$$

7. Why dilute sulphuric acid is used in $KMnO_4$ titration?
Ans: It has two functions
(i) It provides excess H^+ ions in solution which allow the reaction to continue
(ii) It prevents the formation of manganese dioxide

8. Let 3.15 g of oxalic acid are dissolved in 500 cm^3 of solution and its molarity is 0.05. Determine the value of 'x' in $(COOH)_2.xH_2O$ [C= 12, H= 1 , O = 16]
Ans: Calculate the mass of oxalic acid per dm^3 (i.e. 1000 cm^3)

500 cm^3 solution contains oxalic acid $= 3.15$ g

1 cm^3 solution contains oxalic acid $= \frac{3.15}{500}$ g

1000 cm^3 solution contains KOH $= \frac{3.15}{500} \times 1000 = 6.3$ g

Molar mass of oxalic acid $(H_2C_2O_4.xH_2O) = = 12 \times 2 + 16 \times 4 + 1 \times 2 + 18x = 90 + 18x$ g mol^{-1}

Mass of $H_2C_2O_4.xH_2O$ per dm^3 = Molarity (M_2) × Molar mass of $H_2C_2O_4.xH_2O$

$$6.3 = 0.05 \times (90 + 18x)$$

$$90 + 18x = \frac{6.3}{0.05}$$

$$90 + 18x = 126$$

$$18x = 126 - 90$$

$$18x = 36$$

$$x = \frac{36}{18} = 2$$

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PRACTICAL BASED ASSESSMENT (PBA) TEST Marks 06

Q. A 250 cm^3 solution of oxalic acid, $H_2C_2O_4$, was prepared by dissolving a weighed sample of the solid in water. A portion of this solution was titrated against acidified 0.0250 mol dm^{-3} potassium manganate(VII), $KMnO_4$. During the titration, dilute sulfuric acid was added, and the end point was indicated by the appearance of a light permanent pink colour.

(a) Write the fully balanced equation for the redox reaction between acidified potassium manganate(VII) and oxalic acid. **[1]**

(b) State why dilute sulfuric acid must be added before titration. **[1]**

(c) In an experiment, 25.0 cm^3 of oxalic acid solution required 18.60 cm^3 of 0.0250 mol dm^{-3} $KMnO_4$ to reach the end point. Calculate the molarity of oxalic acid solution. **[2]**

(d) Using your result from (c), determine the amount of oxalic acid in the solution, and the mass of oxalic acid present in the full 250 cm^3 solution. *[H= 1, O= 16 , C= 12]* **[2]**

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SOLUTION PRACTICAL BASED ASSESSMENT (PBA) TEST Marks 06

(a)

$$2KMnO_4 + 3H_2SO_4 + \begin{matrix}COOH\\|\\COOH\end{matrix} \cdot xH_2O \rightarrow K_2SO_4 + 2MnSO_4 + (5x+8)H_2O + 10CO_2$$

(b) dilute sulfuric acid has two functions

(i) It provides excess H^+ ions in solution which allow the reaction to continue

(ii) It prevents the formation of manganese dioxide

(c) The molarity of the oxalic acid solution under test is determined with the help of the following equation:

Oxalic acid **$KMnO_4$**

$$\frac{M_1 V_1}{n_1} = \frac{M_2 V_2}{n_2}$$

$$M_1 = \frac{M_2 V_2}{n_2} \times \frac{n_1}{V_1}$$

$$M_1 = \frac{0.0250 \times 18.60}{2} \times \frac{5}{25.0}$$

$$M_1 = 0.0465\ M$$

NOTE:

- Burette reading up to two decimal place **(2 d.p.)** and with four significant figures **3 s.f.**
  Pipette reading with **3 s.f.**
- Molarity of standard solution is 0.0250 M with three s.f. **3 s.f.**
- *Since, least number of **s.f.** in given data is **3**, so all results will be expressed with* **3 s.f.**

(d) Mass of oxalic acid per dm^3 from "c":

Molar mass of oxalic acid ($H_2C_2O_4.2H_2O$) $= 1\times2 + 12\times2 + 16\times4 + 18\times2$

$= 126\ g\ mol^{-1}$

Mass of oxalic acid per dm^3 = Molarity (M_2) × Molar mass of $H_2C_2O_4.xH_2O$

$= 0.0465 \times 126$

$= 5.86\ g\ dm^{-3}$

The mass of oxalic acid per 250 cm^3

1000 cm^3 solution contains oxalic acid = 5.86 g

1 cm^3 solution contains oxalic acid $= \frac{5.86}{1000}$ g

250 cm^3 solution contains oxalic acid $= \frac{5.86}{1000} \times 250 = 1.47$ g

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Experiment 5-A

Determine the value of 'x' by volumetric method is the given sample of 6.3g of $H_2C_2O_4.xH_2O$ dissolved per dm^3. BY REDOX TITRATION

Apparatus used:

Burette, pipette, funnel, conical flask, beakers, iron stand.

Chemicals used:

$H_2C_2O_4.xH_2O$ solution, Distilled water, H_2SO_4 Solution, Standard solution of $KMnO_4$, 0.02M

Chemical Equation:

$$2KMnO_4 + 3H_2SO_4 \rightarrow K_2SO_4 + 2MnSO_4 + 3H_2O + 5[O]$$

$$\left(\begin{matrix} COOH \\ | \\ COOH \end{matrix} \cdot xH_2O + [O] \rightarrow 2CO_2 + (x+1)\,H_2O \right) \times 5$$

Overall Reaction

$$2KMnO_4 + 3H_2SO_4 + \begin{matrix} COOH \\ | \\ COOH \end{matrix} \cdot xH_2O \rightarrow K_2SO_4 + 2MnSO_4 + (5x+8)H_2O + 10CO_2$$

Standard Solution:

0.02 M $KMnO_4$ solution

Mole Ratio from balanced equation:

$KMnO_4$	:	$H_2C_2O_4.xH_2O$
2	:	5

Indicator used:

$KMnO_4$ itself acts as indicator

End Point:

Light pink colour is appeared

Procedure:

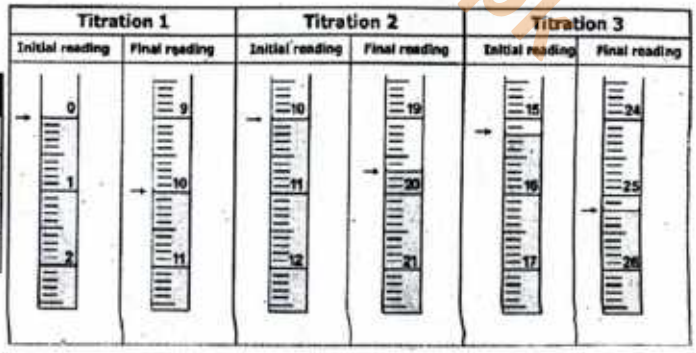
- 6.3 g of $H_2C_2O_4 . xH_2O$ are dissolved per dm^3 of solution
- Fill burette with $KMnO_4$ solution,
- Pipette out 10.0 cm^3 $H_2C_2O_4.xH_2O$ solution and pour into a conical flask.
- Add 10.0 cm^3 H_2SO_4 solution to conical flask and heat.
- Titrate $H_2C_2O_4.xH_2O$ solution with $KMnO_4$ solution till the end point is reached

Instructions:

Repeat the titration as many time as you think necessary to obtain accurate results.
Make certain that the recorded results show the accuracy of your practical work.

Observation Table:

Titration number	1	2	3
Final Reading (cm^3)	10.0	19.7	25.2
First Reading (cm^3)	0.0	10.0	15.2
Volume of $KMnO_4$ used (cm^3)	10.0	9.7	10.0
Best titration result (✓)	✓		✓



From best titration result,

the average volume of $KMnO_4$ used = 10.0 cm^3

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Calculations:

(d) Data for given titration

M_1 = Molarity of $KMnO_4$ solution = 0.02 M
M_2 = Molarity of $H_2C_2O_4.xH_2O$ solution = ?
V_1 = Volume of $KMnO_4$ solution used = 10.0 cm^3
V_2 = Volume of $H_2C_2O_4.xH_2O$ solution used = 10.0 cm^3
n_1 = Number of moles of $KMnO_4$ in balanced equation = 2
n_2 = Number of moles of $H_2C_2O_4.xH_2O$ in balanced equation = 5

(e) Calculation of molarity using the formula $\frac{M_1 V_1}{n_1} = \frac{M_2 V_2}{n_2}$

The molarity of the $H_2C_2O_4.xH_2O$ solution under test is determined with the help of the following equation:

$KMnO_4$ $H_2C_2O_4.xH_2O$

$$\frac{M_1 V_1}{n_1} = \frac{M_2 V_2}{n_2}$$

$$M_2 = \frac{M_1 V_1}{n_1} \times \frac{n_2}{V_2}$$

$$M_2 = \frac{0.02 \times 10}{2} \times \frac{5}{10}$$

$$M_2 = 0.05 \text{ M}$$

(f) Calculate mass of $H_2C_2O_4.xH_2O$ per dm^3 from "b" by using formula:

Mass of $H_2C_2O_4.xH_2O$ per dm^3 = Molarity (M_2) × Molar mass of $H_2C_2O_4.xH_2O$ [H= 1, O= 16, C= 12]

Given mass of $H_2C_2O_4.xH_2O$ dissolved per dm^3 = 6.3 g
Molar mass of $H_2C_2O_4.xH_2O$ = $12 \times 2 + 16 \times 4 + 1 \times 2 + 18x$

Mass of $H_2C_2O_4.xH_2O$ per dm^3 = Molarity (M_2) × Molar mass of $H_2C_2O_4.xH_2O$

$$6.3 = 0.05 \times (90 + 18x)$$

$$90 + 18x = \frac{6.3}{0.05}$$

$$90 + 18x = 126$$

$$18x = 126 - 90$$

$$18x = 36$$

$$x = \frac{36}{18} = 2$$

Result:

The value of 'x' in $H_2C_2O_4.xH_2O$ = 2
Thus, there are two water of crystallization in oxalic acid.

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PRACTICAL BASED ASSESSMENT (PBA) TEST Marks 06

Q. Determine the Value of 'x' by volumetric method in the given sample of 1.575 g of $H_2C_2O_4.xH_2O$ dissolved per 500 cm^3. 0.1M $KMnO_4$ is given.

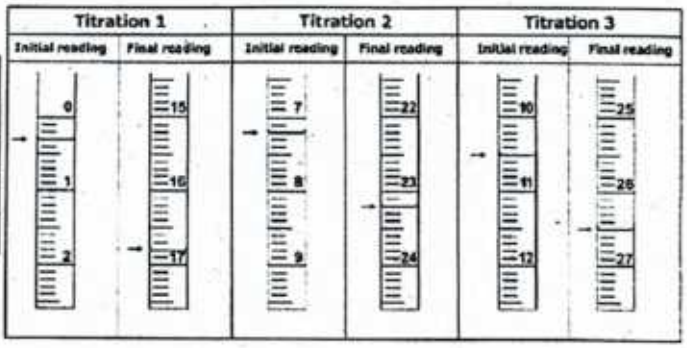
(a) Which indicator is used and what is the color change after the addition of $KMnO_4$ solution? **[1]**

(b) Write overall reaction? **[1]**

(c) See on the figure given below and record the observations in table **[1]**

Observation Table:

Titration number	1	2	3
Final Reading (cm^3)			
First Reading (cm^3)			
Volume of $KMnO_4$ used (cm^3)			
Best titration result (✓)			



From best titration result,
the average volume of $KMnO_4$ used = _____ cm^3

(d) Calculation of molarity of $H_2C_2O_4.xH_2O$ from (c) **[1]**

(e) Calculate number of water of crystallization in $H_2C_2O_4.xH_2O$ *[H= 1, O= 16 , C= 12]* **[2]**

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SOLUTION PRACTICAL BASED ASSESSMENT (PBA) TEST Marks 06

(a) $KMnO_4$ itself acts as an indicator. Light pink which is the endpoint

(b)

$$2KMnO_4 + 3H_2SO_4 + \begin{matrix}COOH\\|\\COOH\end{matrix} \cdot xH_2O \rightarrow K_2SO_4 + 2MnSO_4 + (5x+8)H_2O + 10CO_2$$

(c) Observation Table

Titration number	1	2	3
Final Reading (cm^3)	16.8	23.2	26.5
First Reading (cm^3)	0.3	7.2	10.5
Volume of $KMnO_4$ used (cm^3)	16.5	16.0	16.0
Best titration result (✓)		✓	✓

From best titration result,
the average volume of $KMnO_4$ used = 16.0 cm^3

(d) Calculation of molarity using the formula

$$\underset{KMnO_4}{\frac{M_1 V_1}{n_1}} = \underset{H_2C_2O_4.xH_2O}{\frac{M_2 V_2}{n_2}}$$

$$M_2 = \frac{M_1 V_1}{n_1} \times \frac{n_2}{V_2}$$

$$M_2 = \frac{0.1 \times 10.0}{5} \times \frac{2}{16.0}$$

$$= 0.025 \text{ M}$$

(a) Since 1 dm^3 = 1000 cm^3, so from given mass

500 cm^3 solution contains $H_2C_2O_4.xH_2O$ = 1.575 g

1 cm^3 solution contains $H_2C_2O_4.xH_2O$ = $\frac{1.575}{500}$ g

1000 cm^3 solution contains $H_2C_2O_4.xH_2O$ = $\frac{1.575}{500} \times 1000$ = 3.15 g

(e) Molar mass of $H_2C_2O_4.xH_2O$ = $1 \times 2 + 12 \times 2 + 16 \times 4 + 18x = 90 + 18x$

Mass of $H_2C_2O_4.xH_2O$ per dm^3 = Molarity (M_1) × Molar mass of $H_2C_2O_4.xH_2O$

$$3.15 = 0.025 \times (90 + 18x)$$

$$90 + 18x = \frac{3.15}{0.025} = 126$$

$$18x = 126 - 90 = 36$$

$$x = \frac{36}{18} = 2$$

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IODINE TITRATIONS (IODIMETRY)

06 EXPERIMENT

Estimate the amount of iodine in a given solution by titrating it with standard solution of sodium thiosulfate, $Na_2S_2O_3$ using starch as an indicator.

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Principle:

It is a redox iodimetric titration. Iodine solution is titrated against standard sodium thiosulphate solution in the presence of starch solution which is used as an indicator.

Apparatus:

Burette, Funnel, pipette, Beakers, Stand, Titration flask.

Chemical Equation:

$$2Na_2S_2O_3.5H_2O + I_2 \rightarrow Na_2S_4O_6 + 2NaI + 10H_2O$$

Mole ratio:

$Na_2S_2O_3.5H_2O$: I_2

2 : 1

Standard solution:

0.1 M $Na_2S_2O_3.5H_2O$ solution

Indicator:

1% freshly prepared starch solution

End point:

Light blue colour or just colourless

Procedure:

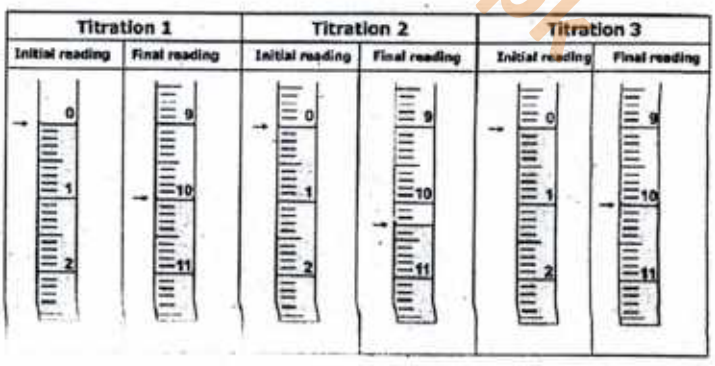
- Fill burette with $Na_2S_2O_3.5H_2O$ solution,
- Pipette out 10.0 cm^3 iodine solution and pour into a conical flask.
- Titrate iodine solution with $Na_2S_2O_3.5H_2O$ solution till the appearance of lemon yellow colour.
- Now add 1.0 cm^3 of freshly prepared starch solution and the colour of solution changes to dark blue.
- Again titrate against $Na_2S_2O_3.5H_2O$ solution until the end point is reached.

Instructions:

Repeat the titration as many time as you think necessary to obtain accurate results.
Make certain that the recorded results show the accuracy of your practical work.

Observations

Titration number	1	2	3
Final Reading (cm^3)	10.0	10.3	10.0
First Reading (cm^3)	0.0	0.0	0.0
Volume of $Na_2S_2O_3$ used (cm^3)	10.0	10.3	10.0
Best titration result (✓)	✓		✓



From best titration result,

the average volume of $Na_2S_2O_3$ solution = 10.0 cm^3

Calculations:

(a) Data for given titration

M_1 = Molarity of iodine (I_2) solution = ?
M_2 = Molarity of $Na_2S_2O_3 . 5H_2O$ solution = 0.1 M
V_1 = Volume of iodine (I_2) solution taken = 10.0 cm^3
V_2 = Volume of $Na_2S_2O_3 . 5H_2O$ solution used = 10.0 cm^3
n_1 = Number of moles of iodine (I_2) in balanced equation = 1
n_2 = Number of moles of $Na_2S_2O_3 . 5H_2O$ in balanced equation = 2

(b) Calculation of molarity using the formula $\frac{M_1 V_1}{n_1} = \frac{M_2 V_2}{n_2}$

Iodine **$Na_2S_2O_3 . 5H_2O$**

$$\frac{M_1 V_1}{n_1} = \frac{M_2 V_2}{n_2}$$

$$M_1 = \frac{M_2 V_2}{n_2} \times \frac{n_1}{V_1}$$

$$M_1 = \frac{0.1 \times 10}{2} \times \frac{1}{10}$$

$$M_1 = 0.05 \text{ M}$$

(c) Calculate mass of iodine (I_2) per dm^3 from "b" : [I= *127]*

Molar mass of I_2 = $127 \times 2 = 254$ g mol^{-1}

Mass of I_2 per dm^3 = Molarity (M_1) × Molar mass of I_2
= 0.05 × 254
= 12.7 g dm^{-3}

Result:

The amount of iodine **(I_2)** in given solution is = 12.7 g dm^{-3}

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VIVA VOCE

1. What is the principle of iodometric titration?

Ans: It is a redox titration in which iodine is reduced to iodide ions (I^-) and thiosulphate ions ($S_2O_3^{2-}$) are oxidized to tetrathionate ions ($S_4O_6^{2-}$).

2. What is the role of sodium thiosulphate in the titration?

Ans: Sodium thiosulphate acts as a **reducing agent**; it reduces iodine (I_2) to iodide (I^-) while itself being oxidized to sodium tetrathionate ($Na_2S_4O_6$).

3. Why is starch solution added near the end point only?

Ans: Because iodine forms a deep blue complex with starch. If added too early, the starch–iodine complex becomes unstable and may give inaccurate results. Near the endpoint, only a small amount of iodine remains, making the colour change (blue → colourless) sharp and distinct.

4. Why must the starch indicator be freshly prepared?

Ans: Starch solution decomposes on standing, forming breakdown products that interfere with the titration and produce a dull or delayed colour change.

5. What is the colour change at the end point?

Ans: The solution changes from dark blue (starch–iodine complex) to colourless at the endpoint.

6. Why is the titration flask kept away from direct sunlight?

Ans: Sunlight decomposes iodine and thiosulphate, leading to loss of iodine vapour and inaccurate results.

7. Calculate the molarity of iodine (I_2) solution if 10.0 cm^3 of I_2 solution requires 10.0 cm^3 of 0.1 M $Na_2S_2O_3$ solution.

The balance equation is: $2Na_2S_2O_3.5H_2O + I_2 \rightarrow Na_2S_4O_6 + 2NaI + 10H_2O$

Thus, the data is:

The molarity, volume and number of moles of iodine are: M_1=? V_1=10.0 cm^3 $n_1 = 1$,

The molarity, volume and number of moles of sodium thiosulphate are: M_2=0.1M, V_2=10.0 cm^3, $n_2 = 2$

Iodine **$Na_2S_2O_3.5H_2O$**

$$\frac{M_1 V_1}{n_1} = \frac{M_2 V_2}{n_2}$$

$$M_1 = \frac{M_2 V_2}{n_2} \times \frac{n_1}{V_1}$$

$$M_1 = \frac{0.1 \times 10}{2} \times \frac{1}{10} = 0.05\ M$$

8. What is the function of starch in this titration?

Ans: Starch acts as an indicator that forms a deep blue complex with iodine, allowing a clear observation of the endpoint when the blue colour disappears.

9. What precaution should be taken during titration?

Ans:

- Avoid exposure of iodine to sunlight.
- Add starch only near the endpoint.
- Use freshly prepared starch solution.

Swirl continuously for proper mixing.

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PRACTICAL BASED ASSESSMENT (PBA) TEST Marks 06

Q. A standard 0.100 M sodium thiosulfate solution (solution A) was used to estimate the amount of iodine in a solution B. During the titration, 25.0 cm^3 of solution B required 20.2 cm^3 of solution A *for complete reaction.*

(a) Write reactions for the iodine solution B with the sodium thiosulphate solution A **[1]**

(b) Describe the colour change observed in the titration flask from the start of the titration to the end-point. **[1]**

(c) Using the data and the equation above, calculate the molarity of the iodine solution (B). **[2]**

(d) How many grams of iodine are present in 25.0 cm^3 of solution B. **[2]**

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SOLUTION PRACTICAL BASED ASSESSMENT (PBA) TEST Marks 06

(a) $2Na_2S_2O_3.5H_2O + I_2 \rightarrow Na_2S_4O_6 + 2NaI + 10H_2O$

(b) At the start, brown or yellow-brown colour appears due to liberation of iodine present. When the colour changes to lemon yellow during titration then starch is added and the deep blue appears. At the end-point blue disappears to colourless.

(c) The molarity, volume and number of moles of iodine are: M_1=? V_1=25.0 cm^3 $n_1 = 1$,
The molarity, volume and number of moles of sodium thiosulphate are: M_2=0.01M, V_2=20.2 cm^3, $n_2 = 2$

Iodine **$Na_2S_2O_3.5H_2O$**

$$\frac{M_1 V_1}{n_1} = \frac{M_2 V_2}{n_2}$$

$$M_1 = \frac{M_2 V_2}{n_2} \times \frac{n_1}{V_1}$$

$$M_1 = \frac{0.1 \times 20.2}{2} \times \frac{1}{25} = 0.0404\ M$$

(d) Molar mass of I_2 = $127 \times 2 = 254\ g\ mol^{-1}$
Mass of I_2 per dm^3 = Molarity (M_1) × Molar mass of I_2
= 0.0404 × 254 = $10.3\ g\ dm^{-3}$

Thus 1000 cm^3 solution contains I_2 = 10.3 g

1 cm^3 solution contains I_2 = $\frac{10.3}{1000}$ g

25.0 cm^3 solution contains I_2 = $\frac{10.3}{1000} \times 25.0 = 0.258$ g

Experiment 6-A — Determination the amount of $Na_2S_2O_3.5H_2O$ in 250 cm^3 given solution. (0.05M Iodine solution is given)

Principle: It is a redox iodimetric titration. Iodine solution is titrated against standard sodium thiosulphate solution in the presence of starch solution which is used as an indicator.

Apparatus: Burette, Funnel, pipette, Beakers, Stand, Titration flask.

Chemical Equation: $2Na_2S_2O_35H_2O + I_2 \rightarrow Na_2S_4O_6 + 2NaI + 10H_2O$

Mole ratio:

$Na_2S_2O_3.5H_2O$: I_2
2 : 1

Standard solution: 0.05M I_2 solution

Indicator: 1% freshly prepared starch solution

End point: Light blue colour or just colourless

Procedure:

- Fill burette with $Na_2S_2O_3.5H_2O$ solution,
- Pipette out 10.0 cm^3 iodine solution and pour into a conical flask.
- Titrate iodine solution with $Na_2S_2O_3.5H_2O$ solution till the appearance of lemon yellow colour.
- Now add 1.0 cm^3 of freshly prepared starch solution and the colour of solution changes to dark blue.
- Again titrate against $Na_2S_2O_3.5H_2O$ solution until the end point is reached.

Instructions:

Repeat the titration as many time as you think necessary to obtain accurate results.

Make certain that the recorded results show the accuracy of your practical work.

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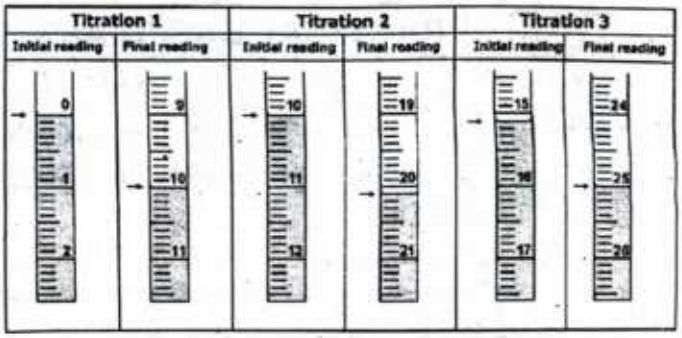
Observations

Titration number	1	2	3
Final Reading (cm^3)	10.0	20.1	25.0
First Reading (cm^3)	0.0	10.0	15.1
Volume of I_2 used (cm^3)	10.0	10.1	9.9
Best titration result (✓)			



From best titration result,
the average volume of I_2 solution = 10.0 cm^3

Calculations:

(a) Data for given titration

M_1 = Molarity of $Na_2S_2O_3.5H_2O$ solution = ?
M_2 = Molarity of iodine (I_2) solution = 0.05 M
V_1 = Volume of $Na_2S_2O_3.5H_2O$ solution used = 10.0 cm^3
V_2 = Volume of iodine (I_2) solution taken = 10.0 cm^3
n_1 = Number of moles of $Na_2S_2O_3.5H_2O$ in balanced equation = 2
n_2 = Number of moles of iodine (I_2) in balanced equation = 1

(b) Calculation of molarity using the formula $\frac{M_1 V_1}{n_1} = \frac{M_2 V_2}{n_2}$

$Na_2S_2O_3.5H_2O$ Iodine

$$\frac{M_1 V_1}{n_1} = \frac{M_2 V_2}{n_2}$$

$$M_1 = \frac{M_2 V_2}{n_2} \times \frac{n_1}{V_1} = \frac{0.05 \times 10.0}{1} \times \frac{2}{10.0} = 0.1\ M$$

(c) Calculate mass of $Na_2S_2O_3.5H_2O$ per dm^3 from "b" : *[Na= 23, S=32, O=16, H=1]*

Molar mass of $Na_2S_2O_3.5H_2O$ = $23\times2 + 32\times2 + 16\times8 + 1\times10 = 248\ g\ mol^{-1}$
Mass of $Na_2S_2O_3.5H_2O$ per dm^3 = Molarity (M_1) × Molar mass of $Na_2S_2O_3.5H_2O$
= 0.1 × 248 = 24.8 g dm^{-3}

Calculate the mass of $Na_2S_2O_3.5H_2O$ per 250 cm^3

1000 cm^3 solution contains $Na_2S_2O_3.5H_2O$ = 24.8 g

1 cm^3 solution contains $Na_2S_2O_3.5H_2O$ = $\frac{24.8}{1000}$ g

250 cm^3 solution contains $Na_2S_2O_3.5H_2O$ = $\frac{24.8}{1000} \times 250 = 6.20$ g

Result: The mass of $Na_2S_2O_3.5H_2O$ in 250 cm^3 of solution = 6.20 g

PRACTICAL BASED ASSESSMENT (PBA) TEST — Marks 06

Q. Determine the Value of 'x' by volumetric method in the given sample of 24.8 g of $Na_2S_2O_3.xH_2O$ dissolved per dm^3 by titration with iodine solution.

(a) Write overall reaction? **[1]**

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(b) Name the suitable indicator for this titration? **[1]**

(c) 10 cm^3 of $Na_2S_2O_3.xH_2O$ requires 20 cm^3 of 0.025 M iodine solution. Determine the molarity $Na_2S_2O_3.xH_2O$ solution. **[1]**

(d) Determine number of water of crystallization in $Na_2S_2O_3.xH_2O$ *[Na= 23, S= 32, H= 1, O= 16]* **[2]**

SOLUTION PRACTICAL BASED ASSESSMENT (PBA) TEST Marks 06

(a) $2Na_2S_2O_3.5H_2O + I_2 \rightarrow Na_2S_4O_6 + 2NaI + 10H_2O$

(b) 1% starch solution is used as indicator. It is added near endpoint. The solution becomes deep blue. On adding sodium thiosulphate from burette, the solution becomes almost colourless. This is the end point.

(c) Calculation of molarity using the formula

$Na_2S_2O_3.5H_2O$ Iodine

$$\frac{M_1 V_1}{n_1} = \frac{M_2 V_2}{n_2}$$

$$M_1 = \frac{M_2 V_2}{n_2} \times \frac{n_1}{V_1}$$

$$M_1 = \frac{0.025 \times 20}{1} \times \frac{2}{10} = 0.10\ M$$

(d) Molar mass of $Na_2S_2O_3.xH_2O = 23\times2 + 32\times2 + 16\times3 + 18x = 158 + 18x\ g\ mol^{-1}$

Mass of $Na_2S_2O_3.xH_2O$ per dm^3 = Molarity (M_1) × Molar mass of $Na_2S_2O_3.xH_2O$

$$24.8 = 0.10 \times (158 + 18x)$$

$$158 + 18x = \frac{24.8}{0.10} = 248$$

$$18x = 248 - 158 = 90$$

$$x = \frac{90}{18} = 5$$

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Section-A

Salt Analysis: Basic Concepts

Radical An atom or a group of atom that behave as single species during reactions is called a radical.
e.g. Cl^{1-}, SO_4^{2-}, SO_3^{2-}, CO_3^{2-}, Na^{1+}, Zn^{2+}, Ca^{2+}, NH_4^{1+} etc.

Salt The ionic substance formed by the neutralization of an acid with a base is called a salt.
A salt is composed of two parts. (i) Acid radical (ii) Basic radical
e.g. NaOH neutralizes HCl to form NaCl (salt) and water.

$$\underset{\text{Base}}{NaOH} + \underset{\text{Acid}}{HCl} \rightarrow \underset{\substack{\text{Basic radical} \\ \text{Acid radical}}}{Na\,Cl} + H_2O$$

Acid Radical The part of the salt obtained from the acid during its formation is called an acid radical. It is the negative portion of the salt. It is also called an anion.
e.g. Cl^{1-}, NO_3^{1-}, SO_4^{2-}, CO_3^{2-} etc.

Basic Radical The part of the salt obtained from base during its formation is called a basic radical It is the positive portion of the salt. It is also called a cation.
e.g. Fe^{2+}, Al^{3+}, Ca^{2+}, Zn^{2+}, NH_4^{1+} etc.

Qualitative Analysis It deals with identification and confirmation of the radicals present in a salt.

Salt Analysis The qualitative analysis of a salt used to find out the acid and basic radical of a salt.

Aqueous Solution (Aq. Sol.) The solution prepared by dissolving salt in water is called aqueous. Solution.

Original Solution (O.S.) The solution prepared by dissolving salt in a solvent is called an original sol.

Precipitate (ppt.) The insoluble solid particles formed in a solution due to some reaction is called precipitate.

Dry Test The test performed on dry salt is called a dry test. e.g. Heating the dry salt in a test tube.

Wet Test The test performed by making solution of the salt is called wet test.

Confirmatory Test The test performed to confirm a radical that has already been identified by dry and wet tes is called a confirmatory test.

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07 EXPERIMENT

Describe tests to identify the following anions

SO_4^{2-}, SO_3^{2-}, CO_3^{2-}, Cl^{1-}, Br^{1-}, I^{1-}, NO_3^{1-}

DETECTION OF ANIONS (ACID RADICALS)

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SALT ANALYSIS SCHEME FOR ACIDIC RADICALS

$O.S. + BaCl_2$ **(Solution)**

ppt. formed $(SO_4^{2-}, SO_3^{2-}, CO_3^{2-})$

Salt + H_2SO_4

- **No effervescence** (SO_4^{2-})
- **Gas evolved with burning sulphur smell** (SO_3^{2-})
- **Colourless, odourless gas evolves with effervescence** (CO_3^{2-})

No ppt. $(Cl^{1-}, Br^{1-}, I^{1-}, NO_3^{1-})$

$O.S. + AgNO_3$

- **White ppt.** (Cl^{1-})
- **Pale Yellow ppt.** (Br^{1-})
- **Yellow ppt.** (I^{1-})
- **No ppt** (NO_3^{1-})

SHORT SCHEME FOR DETECTION / CONFORMATION OF ACIDIC RADICALS

Anions	Reactions
Carbonate (CO_3^{2-})	Salt + dil. H_2SO_4 : CO_2 librated by dilute acids (e.g. H_2SO_4) which turns lime water milky
Sulphate (SO_3^{2-})	Salt + dil. H_2SO_4 : Gas evolved with burning sulphur like smell (SO_2 gas), turn $K_2Cr_2O_7$ paper green
Sulphate (SO_4^{2-})	Salt + dil. H_2SO_4 : No reaction Salt + conc. H_2SO_4 : No reaction Give white ppt. with $BaCl_{2(aq)}$ or with lead acetate$_{(aq)}$
Chloride (Cl^-)	Salt + conc. H_2SO_4 : Colourless gas with pungent smell, gives dense white fumes with $NH_4OH_{(aq)}$ Gives white ppt. with $AgNO_{3(aq)}$ Gives chromyl chloride test
Bromide (Br^-)	Salt + conc. H_2SO_4 : Red vapours evolves and the content of tube becomes red. Give pale yellow ppt. with $AgNO_{3(aq)}$ partially soluble in $NH_4OH_{(aq)}$ Gives orange layer in layer test
Iodide (I^-)	Salt + conc. H_2SO_4 : violet vapours evolves Gives yellow ppt. with $AgNO_{3(aq)}$ insoluble in $NH_4OH_{(aq)}$ Gives violet layer in layer test
Nitrate (NO_3^-)	Salt + conc. H_2SO_4 : Reddish brown gas evolves turn $FeSO_4$ solution black Give brown ring when conc. H_2SO_4 is added to mixture of $FeSO_4$ and salt solution.

Experiment 7-A: Radicals (CO_3^{2-}, SO_3^{2-}, SO_4^{2-})

Carbonate (CO_3^{2-})

No.	EXPERIMENTS	OBSERVATIONS	INFERENCES
Identification of Radical			
1	**Wet Tests** O.S + $BaCl_2$ solution.	White ppt. formed in cold state.	(CO_3^{2-}, SO_3^{2-}, SO_4^{2-}) is present
2	ppt. formed + dil. HCl	Colourless gas evolved with effervescence, turned lime water milky	CO_3^{2-} is indicated.
3	**Dry Test** Salt + dil. H_2SO_4	Colourless gas evolved with effervescence, Turned lime water milky.	CO_3^{2-} is indicated.
Confirmatory Tests *(Wet Tests)*			
4	O.S+$MgSO_4$ solution.	White ppt. in cold state.	CO_3^{2-} is confirmed
5	O.S+$CaCl_2$ solution.	White ppt. in cold state	CO_3^{2-} is confirmed
6	O.S+$SrCl_2$ solution.	White ppt. in cold state.	CO_3^{2-} is confirmed

CHEMICAL EQUATIONS:

1. $Na_2CO_3 + BaCl_2 \rightarrow 2NaCl + BaCO_3$ *(White ppt.)*
2. $BaCO_3 + 2HCl \rightarrow BaCl_2 + H_2O + CO_2$ *(effervescence)*
3. $Na_2CO_3 + H_2SO_4 \rightarrow Na_2SO_4 + H_2O + CO_2$ *(effervescence)*
4. $Na_2CO_3 + MgSO_4 \rightarrow Na_2SO_4 + MgCO_3$ *(White ppt.)*
5. $Na_2CO_3 + CaCl_2 \rightarrow 2NaCl + CaCO_3$ *(White ppt.)*
6. $Na_2CO_3 + SrCl_2 \rightarrow 2NaCl + SrCO_3$ *(White ppt.)*

PRACTICAL BASED ASSESSMENT (PBA) TEST — Marks 03

Q. (i) A student added $BaCl_2$ solution to a portion of the solution of an unknown salt C. A white precipitate appeared. What does this indicate? **[1]**

(ii) A small portion of salt C was treated with dilute H_2SO_4. Colourless effervescence appeared, and the gas turned lime water milky. What does this observation confirm? **[1]**

(iii) When $MgSO_4$ solution was added to the solution of salt C, a white precipitate appeared in cold conditions. What does this observation indicate? **[1]**

SOLUTION PRACTICAL BASED ASSESSMENT (PBA) TEST — Marks 03

(i) Formation of a white precipitate with $BaCl_2$ indicates the presence of a Group I anion (CO_3^{2-}, SO_3^{2-}, SO_4^{2-}).

(ii) Effervescence with gas (CO_2) turning lime water milky confirms CO_3^{2-} ions.

$Na_2CO_3 + H_2SO_4 \rightarrow Na_2SO_4 + H_2O + CO_2$ *(effervescence)*.

(iii) Formation of white precipitate with $MgSO_4$ confirms the presence of CO_3^{2-} ions.

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Sulphite (SO_3^{2-})

No.	EXPERIMENTS	OBSERVATIONS	INFERENCES
Identification of Radical			
	Wet Tests		
1	O.S + $BaCl_2$ solution.	White ppt. formed in cold state.	(CO_3^{2-}, SO_3^{2-}, SO_4^{2-}) is present
2	ppt. formed + dil. HCl	Gas evolved with burning sulphur like smell (SO_2 gas), turn $K_2Cr_2O_7$ paper green	SO_3^{2-} is indicated.
3	**Dry Test** Salt + dil. H_2SO_4	Gas evolved with burning sulphur like smell (SO_2 gas), turn $K_2Cr_2O_7$ paper green	SO_3^{2-} is indicated.
Confirmatory Tests *(Wet Tests)*			
4	O.S.+dil. H_2SO_4 + $KMnO_4$ solution	Colour of $KMnO_4$ discharged.	SO_3^{2-} is confirmed
5	O.S. + $AgNO_3$ solution.	White ppt. in cold state.	SO_3^{2-} is confirmed
6	O.S. + lead acetate solution.	White ppt. unaffected by heating.	SO_3^{2-} is confirmed

CHEMICAL EQUATIONS:

1. $Na_2SO_3 + BaCl_2 \rightarrow 2NaCl + BaSO_3$ ***(White ppt)***
2. $BaSO_3 + 2HCl \rightarrow BaCl_2 + SO_2 + H_2O$
3. $Na_2SO_3 + H_2SO_4 \rightarrow Na_2SO_4 + SO_2 + H_2O$
   $H_2SO_4 + 3SO_2 + K_2Cr_2O_7 \rightarrow K_2SO_4 + H_2O + Cr_2(SO_4)_2$ ***(Green)***
4. $5Na_2SO_3 + 2KMnO_4 + 3H_2SO_4 \rightarrow K_2SO_4 + 2MnSO_4 + 5Na_2SO_4 + 3H_2O$ ***(colourless)***
5. $Na_2SO_3 + 2AgNO_3 \rightarrow 2NaNO_3 + AgSO_3$ ***(White ppt)***
6. $Na_2SO_3 + Pb(CH_3COO)_2 \rightarrow 2CH_3COONa + PbSO_3$ ***(White ppt)***

PRACTICAL BASED ASSESSMENT (PBA) TEST — Marks 03

Q. A solid B was analyzed. Its solution was divided into two portions. The following tests were performed:

Tests	Observations
Test 1: $BaCl_2$ solution added to first portion	White precipitate formed
Test 2: A portion of the salt B was treated with dilute H_2SO_4	Colourless gas with burning sulphur-like smell evolved, turns $K_2Cr_2O_7$ paper green
Test 3: Second portion treated with lead acetate solution	White ppt formed, remains unchanged on heating

(i) What does the observation in Test 1 suggest about the anion? **[1]**

(ii) Which anion is specifically confirmed by Test 2 and why? **[1]**

(iii) Write the formula of the precipitate formed in Test 3 and explain its significance. **[1]**

SOLUTION PRACTICAL BASED ASSESSMENT (PBA) TEST — Marks 03

(i) The formation of white precipitate indicates the presence of a Group I anion (CO_3^{2-}, SO_3^{2-}, SO_4^{2-}).

(ii) SO_3^{2-} (sulphite ion) is confirmed because the SO_2 gas is evolved which has a burning sulphur-like smell and turns $K_2Cr_2O_7$ paper green.

(iii) The precipitate formed is $PbSO_3$. This confirms the presence of SO_3^{2-}.

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Sulphate (SO_4^{2-})

No.	EXPERIMENTS	OBSERVATIONS	INFERENCES
Identification of Radical			
	Wet Tests		
1	O.S. + $BaCl_2$ solution.	White ppt. Formed,	(CO_3^{2-}, SO_3^{2-}, SO_4^{2-}) is present
2	ppt. Formed + dil. HCl	No effervescence. ppt. insoluble	CO_3^{2-}, SO_3^{2-} are absent. SO_4^{2-} is indicated.
	Dry Test		
3	Salt + dil. H_2SO_4	No gas evolves	CO_3^{2-}, SO_3^{2-} are absent. SO_4^{2-} is indicated.
Confirmatory Tests *(Wet Tests)*			
4	O.S. + lead acetate solution.	White ppt. formed, soluble in ammonium acetate.	SO_4^{2-} is confirmed.
5	O.S. + $SrCl_2$ solution.	White ppt. insoluble in conc. HCl	SO_4^{2-} is confirmed.

CHEMICAL EQUATIONS:

1. $Na_2SO_4 + 2BaCl_2 \rightarrow 2NaCl + BaSO_4$ *(White ppt.)*
4. $Na_2SO_4 + (CH_3COO)_2Pb \rightarrow 2CH_3COONa + PbSO_4$ *(White ppt.)*
5. $Na_2SO_4 + SrCl_2 \rightarrow 2NaCl + SrSO_4$ *(White ppt.)*

PRACTICAL BASED ASSESSMENT (PBA) TEST — Marks 03

(i) A student added $BaCl_2$ solution to a portion of Salt A's solution. A white precipitate appeared. The precipitates on treatment with HCl shows no reaction. What does this indicate? **[1]**

(ii) Lead acetate solution was added to a portion of Salt A's solution. A white precipitate formed, which dissolved in ammonium acetate solution. What does this observation indicate? **[1]**

(iii) $SrCl_2$ solution was added to a portion of Salt A's solution. A white precipitate appeared, which was insoluble in concentrated HCl. State the inference. **[1]**

SOLUTION PRACTICAL BASED ASSESSMENT (PBA) TEST — Marks 03

(i) Formation of a white precipitate with $BaCl_2$ indicates the presence of a Group I anion (CO_3^{2-}, SO_3^{2-}, SO_4^{2-}). Absence of effervescence indicates absence of CO_3^{2-}, SO_3^{2-}; the white precipitate confirms the possible presence of SO_4^{2-} ions.

(ii) Formation of a white precipitate that dissolves in ammonium acetate confirms the presence of SO_4^{2-} ions.

(iii) $SrCl_2$ forms a white precipitate with SO_4^{2-} that is insoluble in concentrated HCl.

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VIVA VOCE

Q 1. Name one insoluble carbonate and one insoluble sulphate?
Ans $BaCO_3$, $BaSO_4$

Q 2. Name one soluble carbonate and one soluble sulphate?
Ans Na_2CO_3, Na_2SO_4

Q 3. What happens when $BaCl_2$ solution is added to CO_3^{2-} salt solution?
Ans White ppt. of Barium carbonate ($BaCO_3$) are formed.

$$BaCl_2 + CO_3^{2-} \rightarrow BaCO_3 + 2Cl^-$$

Q 4. What happens when $BaCl_2$ solution is added to SO_4^{2-} salt solution?
Ans White ppt. of Barium carbonate ($BaSO_4$) are formed.

$$BaCl_2 + SO_4^{2-} \rightarrow BaSO_4 + 2Cl^-$$

Q 5. Which gas is evolved when $BaCO_3$ ppt. are treated with dil. HCl?
Ans CO_2 gas is evolved with effervescence

$$BaCO_3 + 2HCl \rightarrow BaCl_2 + H_2O + CO_2 \text{ (effervescence)}$$

Q 6. When $BaCl_2$ solution is added in salt solution, white precipitates are formed. Suppose, this is the indication of SO_4^{2-} or SO_3^{2-}, CO_3^{2-}, how can you identify that precipitates are of CO_3^{2-}
Ans The white ppt. are treated with dil. HCl. If a gas evolves with effervescence and turns lime water milky, then it is CO_3^{2-}

$$BaCO_3 + 2HCl \rightarrow BaCl_2 + H_2O + CO_2 \text{ (effervescence)}$$

Q 7. $MgSO_4$, $CaCl_2$ and $SrCl_2$ solutions can be used to confirm the presence of carbonate ions. How?
Ans $MgSO_4$, $CaCl_2$ and $SrCl_2$ form insoluble ppt. of $MgCO_3$, $CaCO_3$ and $SrCO_3$

$$CO_3^{2-} + MgSO_4 \rightarrow SO_4^{2-} + MgCO_3 \textit{ (White ppt.)}$$
$$CO_3^{2-} + CaCl_2 \rightarrow SO_4^{2-} + CaCO_3 \textit{ (White ppt.)}$$
$$CO_3^{2-} + SrCl_2 \rightarrow SO_4^{2-} + SrCO_3 \textit{ (White ppt.)}$$

Q 8. What happens when lead acetate solution is added to sulphate ions solution
White ppt. of lead acetate are formed which are soluble in ammonium acetate.

$$SO_4^{2-} + (CH_3COO)_2Pb \rightarrow 2CH_3COO^- + PbSO_4 \textit{ (White ppt.)}$$

Q 9. Write the formula for the following (i) Sodium nitroprusside (ii) Lead acetate
Ans (i) Sodium nitroprusside $Na_2[Fe(CN)_5NO]$ (ii) Lead acetate $(CH_3COO)_2Pb$

Q 10. How CO_2 gas can be detected?
Lime water is solution of lime CaO in water. When CaO is dissolved in water it reacts with water to produce $Ca(OH)_2$. When CO_2 is passed through lime water it reacts with $Ca(OH)_2$ and produce $CaCO_3$. Therefore, lime water turns milky due to the formation of $CaCO_3$

$$Ca(OH)_2 + CO_2 \rightarrow CaCO_3 + H_2O$$

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PRACTICAL BASED ASSESSMENT (PBA) TEST-1 Marks 06

Q. A chemistry teacher provided two unknown salts, X and Y, to identify their acid radicals. Salt X is known to contain either carbonate or sulphite radical, and salt Y is suspected to contain carbonate or sulphate radical.

(a) Tests on Salt X

(i) A student performs a dry test on X by adding dilute H_2SO_4. A colourless, odourless gas evolved. What is this gas and how it can be confirmed? **[1]**

(ii) To aqueous solution of X, add $BaCl_2$ solution and then dilute HCl. Write your observation. **[1]**

(iii) Which radical is indicate by test (i) and (ii) for salt X? **[1]**

(b) Tests on Salt Y

Specific amount of Y was dissolved in distilled water and divided into two portions. The following observations were recorded:

Tests	Observations
Test 1: Appearance of Y	White crystalline solid
Test 2: To first portion, add $BaCl_2$ solution, then dilute HCl	White precipitate formed, did not effervesce
Test 3: To second portion, add $SrCl_2$ solution	White precipitate formed, insoluble in conc. HCl

(i) Name the radical present in solution Y. **[1]**

(ii) Write one confirmatory test for this radical. **[1]**

(iii) Write the name of Y. **[1]**

SOLUTION PRACTICAL BASED ASSESSMENT (PBA) TEST-1 Marks 06

(a) Tests on Salt X

(i) Colourless, odourless gas is CO_2. This, evolved with effervescence. When it is passed through lime water, it turns milky.

(ii) White precipitate formed with $BaCl_2$; effervescence observed on adding dilute HCl.

(iii) Tests (i) and (ii) confirms the presence of CO_3^{2-} radical.

(b) Tests on Salt Y

(i) Radical present in solution Y: SO_4^{2-}

(ii) Confirmatory test: White ppt. with lead acetate solution, insoluble in ammonium acetate

(iii) Name of Y: Barium sulfate / Sodium sulfate / Potassium sulfate

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PRACTICAL BASED ASSESSMENT (PBA) TEST-2 Marks 06

Two solids, P and Q, were provided for analysis. Sample P is suspected to contain sulphite radical, while sample Q is expected to contain sulphate radical.

(a) Tests on solid P

(i) A student perfoms a dry test on P by adding dilute H_2SO_4. What is observed? **[1]**

(ii) To the first portion of solution P, add $BaCl_2$ solution and then dilute HCl. Write your observation. **[1]**

(iii) To another portion of solution P, add $AgNO_3$ solution. Write your observation. **[1]**

(b) Tests on solid Q

Specific amount of Q was dissolved in distilled water and divided into two portions. The following observations were recorded:

Tests	Observations
Test 1: Appearance of Q	White crystalline solid
Test 2: To first portion, add $BaCl_2$ solution, then dilute HCl	White precipitate formed, no effervescence
Test 3: To second portion, add lead acetate solution	White precipitate formed, soluble in ammonium acetate

(i) Name the radical present in solution Q. **[1]**

(ii) Write one confirmatory test for this radical. **[1]**

(iii) Write the name of Q. **[1]**

SOLUTION PRACTICAL BASED ASSESSMENT (PBA) TEST-2 Marks 06

(a) Tests on Sample P

(i) Gas evolved with burning sulphur-like smell (SO_2); turns $K_2Cr_2O_7$ paper green. SO_3^{2-} radical indicated.

(ii) White precipitate formed with $BaCl_2$; gas evolved on adding dilute HCl with burning sulphur smell. Confirms SO_3^{2-} radical.

(iii) Colour of $KMnO_4$ discharged on addition to solution. SO_3^{2-} radical confirmed.

(b) Tests on Sample Q

(i) Radical present in solution Q: SO_4^{2-}

(ii) Confirmatory test: White ppt with $SrCl_2$ solution, insoluble in conc. HCl

(iii) Name of Q: Barium sulfate / Sodium sulfate / Potassium sulfate

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PRACTICAL BASED ASSESSMENT (PBA) TEST-3 Marks 06

Q A student performs tests on two salts 'A' and 'C' to detect acid radicals.

(a) Tests on 'C'

(i) A student added $BaCl_2$ solution to a portion of the solution of an unknown salt C. A white precipitate appeared. The precipitates formed were treated with dilute HCl. A colourless gas evolved with effervescence, and the gas turned lime water milky. State the inference. **[1]**

(ii) A portion of salt C's solution was treated with $CaCl_2$ solution. White precipitate formed immediately. State the inference. **[1]**

(iii) $SrCl_2$ solution was added to a portion of the solution of salt C. A white precipitate appeared immediately. What does this confirm? **[1]**

(b) Tests on 'A'

(i) A small portion of Salt A's solution was treated with dilute H_2SO_4. No gas was evolved. What does this observation confirm? **[1]**

(ii) Lead acetate solution was added to a portion of Salt A's solution. A white precipitate formed, which dissolved in ammonium acetate solution. What does this observation indicate? **[1]**

(iii) Why is $SrCl_2$ used as a confirmatory test for SO_4^{2-} even after $BaCl_2$ testing? **[1]**

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SOLUTION PRACTICAL BASED ASSESSMENT (PBA) TEST-3 Marks 06

(a) Tests on 'C'

(i) Evolution of gas that turns lime water milky confirms the presence of CO_3^{2-} ions.

(ii) Formation of white precipitate with $CaCl_2$ confirms CO_3^{2-} ions.

(iii) Formation of a white precipitate with $SrCl_2$ confirms CO_3^{2-} ions.

(b) Tests on 'A'

(i) No gas evolution confirms that CO_3^{2-} and SO_3^{2-} are absent, supporting the presence of SO_4^{2-} ions.

(ii) Formation of a white precipitate that dissolves in ammonium acetate confirms the presence of SO_4^{2-} ions.

$$SO_4^{2-} + (CH_3COO)_2Pb \rightarrow 2CH_3COO^- + PbSO_4 \quad \textit{(White ppt.)}$$

(iii) $SrCl_2$ forms a white precipitate with SO_4^{2-} that is insoluble in concentrated HCl, providing additional confirmation of SO_4^{2-} ions.

Experiment 7-B: Radicals (Cl^{1-}, Br^{1-}, I^{1-}, NO_3^{1-})

Chloride (Cl^{1-})

No.	EXPERIMENTS	OBSERVATIONS	INFERENCES
Identification of Radical			
1	**Wet Tests** O.S. + $BaCl_2$ solution.	No ppt. Formed	(CO_3^{2-}, SO_4^{2-}, SO_3^{2-}) is absent (Cl^{1-}, Br^{1-}, I^{1-}, NO_3^{1-}) may be present
2	O.S. + dil. HNO_3 + $AgNO_3$ solution.	White ppt. soluble in NH_4OH.	Cl^{1-} is indicated.
3	**Dry Test** Salt + conc. H_2SO_4	Colourless gas evolves with pungent smell (HCl gas). It gives dense white fumes with glass rod dipped in NH_4OH.	Cl^{1-} is indicated.
Confirmatory Tests *(Dry Tests)*			
4	Chromyl chloride test $Salt_{(s)} + K_2Cr_2O_{7\,(s)}$ + Conc. H_2SO_4 + heat.	Reddish brown fumes of chromyl chloride (CrO_2Cl_2) evolved, gave yellow ppt when pass through NaOH & then through $Pb(CH_3COO)_2$ solution	Cl^{1-} is confirmed.
5	$Salt_{(s)}$ + $MnO_{2(s)}$ + conc. H_2SO_4.	Greenish yellow gas with pungent smell evolved.	Cl^{1-} is confirmed.

CHEMICAL EQUATIONS:

2. $AgNO_3 + NaCl \rightarrow NaNO_3 + AgCl$ *(White ppt.)*
   $AgCl + 2NH_4OH \rightarrow [Ag(NH_3)_2]Cl + 2H_2O$
3. $2NaCl + H_2SO_4 \rightarrow Na_2SO_4 + 2HCl$ *(colourless gas with pungent smell)*
   $HCl + NH_4OH \rightarrow H_2O + 2NH_4Cl$ *(dense white fumes)*
4. $4NaCl + K_2Cr_2O_7 + 3H_2SO_4 \rightarrow K_2SO_4 + 2Na_2SO_4 + 3H_2O + 2CrO_2Cl_2$ *(reddish brown fumes)*
   $CrO_2Cl_2 + 4NaOH \rightarrow 2NaCl + 2H_2O + Na_2CrO_4$
   $Na_2CrO_4 + (CH_3COO)_2Pb \rightarrow 2CH_3COONa + PbCrO_4$ *(Yellow ppt.)*
5. $2NaCl + MnO_2 + 3H_2SO_4 \rightarrow 2NaHSO_4 + MnSO_4 + 2H_2O + Cl_2$ *(Greenish yellow fumes)*

PRACTICAL BASED ASSESSMENT (PBA) TEST — Marks 03

Q. A solid W was analyzed. It contains a chloride radical. Complete the expected observations.

(i) A small amount of W was dissolved in distilled water. To this solution, dilute HNO_3 and aqueous $AgNO_3$ was added, followed by addition of NH_4OH solution. Describe the observations. **[1]**

(ii) A few crystals of W were mixed with potassium dichromate and concentrated sulfuric acid in a dry test-tube and heated gently. What is observed? **[1]**

(iii) A few crystals of W were added to conc. sulfuric acid in a test-tube. When heated and a glass rod dipped in concentrated ammonia is brought near the evolved gas, what is observed? **[1]**

SOLUTION PRACTICAL BASED ASSESSMENT (PBA) TEST — Marks 03

(i) White precipitate forms with $AgNO_3$, which dissolves in NH_4OH. $AgNO_3 + NaCl \rightarrow NaNO_3 + AgCl$ *(White ppt.)*

(ii) Reddish-brown fumes of chromyl chloride evolve.

(iii) Colourless pungent gas HCl evolves. This gives dense white fumes on the glass rod dipped in NH_3.

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Bromide (Br^{1-})

No.	EXPERIMENTS	OBSERVATIONS	INFERENCES
Identification of Radical			
1	**Wet Tests** O.S. + $BaCl_2$ solution.	No ppt. Formed	(CO_3^{2-}, SO_4^{2-}, SO_3^{2-}) is absent (Cl^{1-}, Br^{1-}, I^{1-}, NO_3^{1-}) may be present
2	O.S. + dil. HNO_3 + $AgNO_3$ solution.	Pale yellow ppt. partially soluble in NH_4OH.	Br^{1-} is indicated.
3	**Dry Test** Salt + conc. H_2SO_4	Reddish brown gas evolved and the content of tube becomes red.	Br^{1-} is indicated.
Confirmatory Tests			
4	Layer Test O.S. + CCl_4 + drops of $KMnO_4$ + dil. H_2SO_4 + shake	CCl_4 layer turned orange.	Br^{1-} is confirmed.
5	Salt(s) + MnO_2(s) + conc. H_2SO_4.	Reddish brown vapours of Br_2 formed.	Br^{1-} is confirmed.

CHEMICAL EQUATIONS:

2. $NaBr + AgNO_3 \rightarrow NaNO_3 + AgBr$ *(Pale yellow ppt.)*
3. $2NaBr + H_2SO_4 \rightarrow Na_2SO_4 + 2HBr$
   $2HBr + H_2SO_4 \rightarrow 2H_2O + SO_2 + Br_2$ *(Reddish brown vapours)*
4. $10KBr + 2KMnO_4 + 8H_2SO_4 \rightarrow 6K_2SO_4 + 2MnSO_4 + 8H_2O + 5Br_2$ *(Orange colour in CCl_4)*
5. $2NaBr + MnO_2 + 2H_2SO_4 \rightarrow Na_2SO_4 + MnSO_4 + 2H_2O + Br_2$ *(Reddish brown vapours)*

PRACTICAL BASED ASSESSMENT (PBA) TEST — Marks 03

Q. A solid 'B' was analyzed. Its solution was divided into two portions and following tests were performed:

Tests	Observations
Test 1: $BaCl_2$ solution added to first portion	No precipitate formed
Test 2: $AgNO_3$ solution added to the same portion	Pale yellow precipitate formed, partially soluble in NH_4OH
Test 3: Another portion treated with concentrated H_2SO_4	Reddish brown gas evolved and contents of tube turned red

(i) What does the observation in Test 1 suggest about the anion? **[1]**

(ii) Which anion is specifically indicated by Test 2 and why? **[1]**

(iii) Name the gas evolved in Test 3 and explain its significance. **[1]**

SOLUTION PRACTICAL BASED ASSESSMENT (PBA) TEST — Marks 03

(i) The absence of precipitate indicates that Group I anions (CO_3^{2-}, SO_4^{2-}, SO_3^{2-}) are absent, so a Group II anion (Cl^{1-}, Br^{1-}, I^{1-}, NO_3^{1-}) may be present.

(ii) Br^- is indicated because it forms a pale yellow AgBr precipitate that is partially soluble in NH_4OH.

(iii) The gas is Br_2. Its reddish brown color confirms the presence of Br^-.

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Iodide (I^{1-})

No.	EXPERIMENTS	OBSERVATIONS	INFERENCES
Identification of Radical			
1	**Wet Tests** O.S. + $BaCl_2$ solution.	No ppt. Formed	(CO_3^{2-}, SO_4^{2-}, SO_3^{2-}) is absent (Cl^{1-}, Br^{1-}, I^{1-}, NO_3^{1-})may be present
2	O.S.+dil. HNO_3+$AgNO_3$ solution.	Deep yellow ppt. slightly soluble in NH_4OH.	I^{1-} is indicated.
3	**Dry Test** Salt + conc. H_2SO_4	Violet vapours of I_2 evolved, turned starch paper blue.	I^{1-} is indicated.
Confirmatory Tests *(Wet Tests)*			
4	O.S. + $Pb(CH_3COO)_2$ solution.	Yellow ppt. formed.	I^{1-} is confirmed.
5	Layer Test O.S.+CCl_4 +1-2 drops $KMnO_4$ solution + dil. H_2SO_4 + shake	CCl_4 layer turned violet.	I^{1-} is confirmed.
6	O.S. + $HgCl_2$ solution.	Scarlet red ppt. formed, soluble in excess of KI.	I^{1-} is confirmed.

CHEMICAL EQUATIONS:

2. $NaI + AgNO_3 \rightarrow NaNO_3 + AgI$ *(Deep yellow ppt.)*
3. $2NaI + H_2SO_4 \rightarrow Na_2SO_4 + 2HI$
   $2HI + H_2SO_4 \rightarrow 2H_2O + SO_2 + I_2$ *(violet vapours)*
4. $2NaI + (CH_3COO)_2Pb \rightarrow 2CH_3COONa + PbI_2$ *(Yellow ppt.)*
5. $10KI + 2KMnO_4 + 8H_2SO_4 \rightarrow 6K_2SO_4 + 2MnSO_4 + 8H_2O + 5I_2$ *(Violet colour in CCl_4)*
6. $2NaI + HgCl_2 \rightarrow 2NaCl + HgI_2$ *(Scarlet red ppt.)*

PRACTICAL BASED ASSESSMENT (PBA) TEST — Marks 03

Q. A solid W was analyzed. Study the observations below and answer the related questions.

(i) When a solution of W was treated with dil. HNO_3 followed by silver nitrate solution, a yellow precipitate formed which was slightly soluble in dilute ammonia. What radical is suggested by this observation? **[1]**

(ii) When a few crystals of W were added to concentrated sulfuric acid, violet fumes evolved that turned starch paper blue. What does this indicate? **[1]**

(iii) When W was shaken with carbon tetrachloride and treated with potassium permanganate in acidic medium, the CCl_4 layer turned violet. What conclusion can be drawn? **[1]**

SOLUTION PRACTICAL BASED ASSESSMENT (PBA) TEST — Marks 03

(i) The observation suggests the presence of a halide that forms a yellow silver salt. This may be iodide (I^-).

(ii) The violet fumes indicate elemental iodine is released, confirming the halide in W is iodide.

(iii) The violet color confirms the presence of iodide (I^-) in W.

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Nitrate (NO_3^{1-})

No.	EXPERIMENTS	OBSERVATIONS	INFERENCES
Identification of Radical			
1	O.S. + $BaCl_2$ solution.	No ppt. Formed	(CO_3^{2-}, SO_4^{2-}, SO_3^{2-}) is absent (Cl^{1-}, Br^{1-}, I^{1-}, NO_3^{1-}) may be present
2	O.S. + dil. HNO_3 + $AgNO_3$ solution.	No ppt. Formed	NO_3^{1-} is indicated.
3	**Dry Test** Salt + conc. H_2SO_4	Reddish brown gas evolved with pungent smell. Turned $FeSO_4$ solution black.	Cl^{1-}, Br^{1-}, I^{1-} are absent NO_3^{1-} is indicated.
Confirmatory Tests *(Wet Tests)*			
4	Ring Test O.S. + fresh solution of $FeSO_4$ + conc. H_2SO_4 along the sides of the test tube.	A dark brown ring formed at the junction of two solutions.	NO_3^{1-} is confirmed.
5	O.S. + Dilphenylamine solution.	Deep blue colour was produced.	NO_3^{1-} is confirmed.
6	O.S. + NaOH + Aℓ foil (or Zn dust) + heat.	NH_3 gas evolved, gave white fumes with HCl.	NO_3^{1-} is confirmed.

CHEMICAL EQUATIONS:

3. $2NaNO_3 + H_2SO_4 \rightarrow Na_2SO_4 + H_2O + 2NO_2$ ***(Reddish brown gas)***
4. $FeSO_4 + 3NO_2 + H_2O \rightarrow 2HNO_3 + FeSO_4.NO$ ***(Brown ring)***
6. $2NaNO_3 + 6NaOH + 8Aℓ + 6H_2O \rightarrow 8NaAlO_2 + 2NH_3$

$NH_3 + HCl \rightarrow NH_4Cl$ ***(dense white fumes)***

PRACTICAL BASED ASSESSMENT (PBA) TEST — Marks 03

Q. A solid D was analyzed. Its solution was divided into two portions. The following tests were performed:

Tests	Observations
Test 1: Another portion heated with conc. H_2SO_4	Brown gas evolved, giving reddish-brown fumes and turn $FeSO_4$ solution black
Test 2: O.S. + $FeSO_4$ solution + conc. H_2SO_4	Dark brown ring formed at the junction of the two solutions
Test 3: O.S. + NaOH + Aℓ foil, heat	Ammonia gas evolved, giving white fumes with HCl

(i) What does the observation in Test 1 indicate? **[1]**

(ii) Which radical is specifically confirmed by Test 2 and how? **[1]**

(iii) What does Test 3 confirm and why? **[1]**

SOLUTION PRACTICAL BASED ASSESSMENT (PBA) TEST — Marks 03

(i) The evolution of brown NO_2 gas confirms the presence of nitrate ions (NO_3^-).

(ii) NO_3^- is confirmed because the dark brown ring forms due to the nitroso-Fe complex.

(iii) Nitrate reacts with Aℓ/NaOH on heating to liberate ammonia, which gives white fumes with HCl.

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VIVA VOCE

Q 1. How NO_2 gas can be identified?
Ans It is brown in colour with pungent odour and it turns $FeSO_4$ paper black

Q 2. How HCl gas be tested chemically?
Ans It gives white dense fumes of NH_4Cl with NH_4OH

Q 3. How presence of iodine in a salt is indicated?
Ans It gives violet vapours when conc. H_2SO_4 is added to a salt. These vapours turns starch paper blue

Q 4. What are the colours of following precipitates? AgCl, AgBr, AgI
Ans AgCl: White AgBr: Pale Yellow AgI: Deep Yellow

Q 5. What is Ring Test? What is its significance?
Ans This test is used for the confirmation of nitrate (NO_3^{1-}) radical.
Salt solution + $FeSO_4$ solution + conc. H_2SO_4 along the sides of test tube
A brown ring is formed at the junction of two solutions

$$FeSO_4 + NO \rightarrow FeSO_4.NO \text{ (Brown ring)}$$

Q 6. How Br^- and NO_3^- can be distinguished from each other?
Ans Salt is treated with conc. H_2SO_4
(i) If reddish brown gas is evolved and content of test tube is red then the radical is Br^{1-}
(ii) If reddish brown gas is evolved and intensity of gas is increased by adding paper pallet then the radical is NO_3^{1-}

Q 7. What is chromyl chloride test?
Ans This test is used for the detection of chlorides (Cl^{1-}) radical
In this, solid salt, solid potassium dichromate concentrated sulphuric acid are heated together. Reddish brown fumes of chromyl chloride (CrO_2Cl_2)are evolved.

$$K_2Cr_2O_7 + 6H_2SO_4 + 4NaCl \rightarrow 2KHSO_4 + 4NaHSO_4 + 2CrO_2Cl_2 + 3H_2O$$

Q 8. Bromides and iodides both form yellow ppt. with $AgNO_3$ solution? How will you made distinction between them?
Ans Bromides and iodides react with $AgNO_3$ to give yellow precipitates of AgBr and AgI respectively

$$Br^{1-} + AgNO_3 \rightarrow AgBr + NO_3^{1-}$$
$$I^{1-} + AgNO_3 \rightarrow AgI + NO_3^{1-}$$

The yellow precipitates of AgBr and AgI are dissolved in NH_4OH,
(i) If yellow ppt. are partially soluble then Br^{1-} is present.
(ii) If yellow ppt. are insoluble then I^{1-} is present.

Q 9. Write name and formula of water soluble complex formed when AgCl dissolved in NH_4OH.
Ans $[Ag(NH_3)_2]Cl$ diammine silver (I) chloride.

Q 10. (i) Write one radical which does not give ppt. with $AgNO_3$ solution?
Nitrate (NO_3^{1-}) radical does not give ppt. with $AgNO_3$ solution.

$$NO_3^{1-} + AgNO_3 \rightarrow \text{No ppt.}$$

(ii) Write one radical which gives white ppt. with $AgNO_3$ solution?
Chlroide (Cl^{1-}) radical gives white ppt. with $AgNO_3$ solution

$$Cl^{1-} + AgNO_3 \rightarrow NO_3^{1-} + AgCl \text{ (White ppt.)}$$

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PRACTICAL BASED ASSESSMENT (PBA) TEST-1 Marks 06

Q. Two solids A and B were analyzed. Solid A contains chloride radical (Cl^-) and solid B contains another acid radical.

(a) Tests on A

(i) A student performs a dry test on A by adding concentrated H_2SO_4. What is observed? **[1]**

(ii) To the first portion of solution A, add dilute nitric acid followed by aqueous silver nitrate. Write its observation. **[1]**

(iii) To another portion of solution A, perform the chromyl chloride test using $K_2Cr_2O_7$ + conc. H_2SO_4 + heat. Write your observation. **[1]**

(b) Tests on B

Specific amount of B was dissolved in distilled water and divided into two portions. The following observations were recorded:

Tests	Observations
Test 1: Salt + conc. H_2SO_4	Reddish brown fumes evolved. The contents of tube become red.
Test 2: To first portion, add aqueous $AgNO_3$, then few drops NH_4OH	Cream precipitate formed, partially soluble in NH_4OH
Test 3: To second portion, add CCl_4 + $KMnO_4$ + dil. H_2SO_4 and shake	CCl_4 layer turned orange

(i) Name the radical present in solution B. **[1]**

(ii) Write the formula of the precipitate formed in Test 2. **[1]**

(iii) Why the CCl_4 layer turned orange in Test 3. **[1]**

SOLUTION PRACTICAL BASED ASSESSMENT (PBA) TEST-1 Marks 06

(a) Tests on A

(i) Colourless pungent gas evolved (HCl) when concentrated H_2SO_4 was added. Cl^- radical is indicated.

(ii)White precipitate formed with $AgNO_3$, soluble in NH_4OH. Confirms presence of Cl^- radical.

(iii) Reddish brown fumes of chromyl chloride evolved. Confirms Cl^- radical.

(b) Tests on B

(i) Radical present in B is Bromide (Br^-)

(ii) Formula of precipitate in Test 2: AgBr

(iii) The CCl_4 layer turned orange because the Br_2 formed in the reaction goes into CCl_4 layer.

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PRACTICAL BASED ASSESSMENT (PBA) TEST-2 Marks 06

Two solids A and B were analyzed. Solid A contains iodide radical (I^-) and solid B contains a sodium salt of other acidic radical.

(a) Tests on A

(i) A student performs a dry test on A by adding concentrated H_2SO_4. What is observed? **[1]**

(ii) To the first portion of solution A, add dilute nitric acid followed by aqueous silver nitrate. Write its observation. **[1]**

(iii) To another portion of solution A, add $Pb(CH_3COO)_2$ solution. Write your observation. **[1]**

(b) Tests on B

Specific amount of B was dissolved in distilled water and divided into portions. The following observations were recorded:

Tests	Observations
Test 1: Salt + conc. H_2SO_4	Reddish brown gas evolved, turns $FeSO_4$ solution black.
Test 2: Add dilute HNO_3 followed by $AgNO_3$	No precipitate formed
Test 3: Salt + $FeSO_4$ solution + conc. H_2SO_4	Brown ring formed.

(i) Name the gas evolved in Test 1. **[1]**

(ii) Name the radical present in solution B. **[1]**

(iii) Name the salt B. Write its formula **[1]**

SOLUTION PRACTICAL BASED ASSESSMENT (PBA) TEST-2 Marks 06

(a) Tests on A

(i) Violet vapours evolved; turned starch paper blue. I^- radical is indicated.

(ii) Deep yellow precipitate forms with $AgNO_3$, insoluble in NH_4OH. This confirms presence of I^- radical.

(iii) Yellow precipitate forms with $Pb(CH_3COO)_2$ solution. I^- radical is confirmed.

(b) Tests on B

(i) The reddish brown gas evolved is nitrogen peroxide (NO_2)

(ii) Radical present in salt B is Nitrate ion (NO_3^-)

(iii) Name of B: Sodium nitrate, $NaNO_3$

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08 EXPERIMENT

Describe dry/ wet tests to identify the following cations by using reagents such as aqueous sodium hydroxide and aqueous ammonia

Cu^{2+}, Fe^{2+}, Fe^{3+}, Ca^{2+}, Al^{3+}, Cr^{3+}, Zn^{2+}, NH_4^{1+}

DRY TESTS

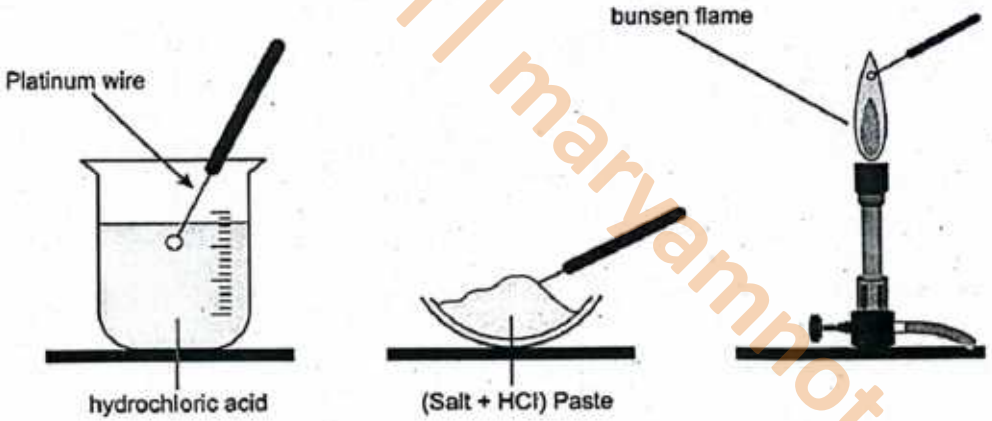
Colour of Salts

Observation	Inference	Observation	Inference	Observation	Inference
Blue Yellowish brown	May be Cu^{2+} May be Fe^{3+}	Light green Dark green	May be Fe^{2+} May be Cr^{3+}	White or colourless	Cu^{2+} Fe^{3+} Fe^{2+} Cr^{3+} are absent

Flame Test

Take a clean platinum wire and make a small loop at its end. Dip it in conc. HCl. Heat it in oxidizing flame till no colour appear in the flame.

Mix small amount of salt with little conc. HCl to form a paste. Take the paste onto the platinum wire. Heat the paste in oxidizing flame. Note the colour of the flame with naked eye and through blue glass



Sr.	Colour of flame through naked eye	Colour through blue glass	Inference
1	Bluish green	Blue	Cu^{2+}
2	Brick red	Light green	Ca^{2+}

Filter Ash Test

Take small amount of salt in a test tube. Add small amount of cobalt nitrate solution. Dip a piece of filter paper into the solution. Dry the filter paper. Burn the filter paper and note the colour of the ash.

Sr.	Observation	Inference	Sr.	Observation	Inference
1	Green	Zn^{2+} salts	2	Blue	Al^{3+} salts

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Salt solution + cobalt nitrate

Filter paper dipped in solution

Filter paper burning

Note the ash Colour

Chemistry of the filter ash test

Salts of Zn^{2+}, Al^{3+} are decomposed into their oxides on heating. $Co(NO_3)_2$ also decomposed to CoO. The oxides of metals then react with CoO to form the ash of characteristic colour.

For Zn^{2+} salts	For Al^{3+} salts
$2Co(NO_3)_2 \longrightarrow 2CoO + 4NO_2 + O_2$	$2Co(NO_3)_2 \longrightarrow 2CoO + 4NO_2 + O_2$
$ZnCO_3 \longrightarrow ZnO + CO_2$	$Al_2(SO_4)_3 \longrightarrow Al_2O_3 + 3SO_2$
$ZnO + CoO \longrightarrow ZnO.CoO$	$Al_2O_3 + CoO \longrightarrow Al_2O_3.CoO$

Wet Tests

1. Preparation of Original Solution (O.S.) for wet test analysis for basic radicals.

- If salt is soluble in water then the salt is dissolved in distilled water and this solution is called as original solution (O.S.) or aqueous solution (aq. Solution).
- If the salt is insoluble in water then the original solution (O.S.) is prepared as follows.
  Dissolve the salt in the following solvents in cold and hot state in the given order.
  (i) Dilute HCl (ii) Conc. HCl (iii) Dilute HNO_3
  (iv) Conc. HNO_3 (v) Aqua Regia (3 volume of conc. HCl + 1 volume of conc. HNO_3)
- If O.S. is prepared in conc. HCl then dilute the solution with distilled water and proceed for the analysis.
- If O.S. is prepared in HNO_3 or aqua regia, then evaporate the solution to dryness and then add distilled water to the remaining residue and called it O.S.

2. Preparation of original solution (O.S.) for wet test analysis for acid radicals.

Mix 1 g of salt with 4g sodium carbonate in a test tube. Add about 10-15 cm^3 of distilled water. Boil it for sometime. Filter it and throw away the precipitate. To the filtrate add acetic acid till the effervescence stops.
Boil off CO_2. This is the original solution (O.S.).

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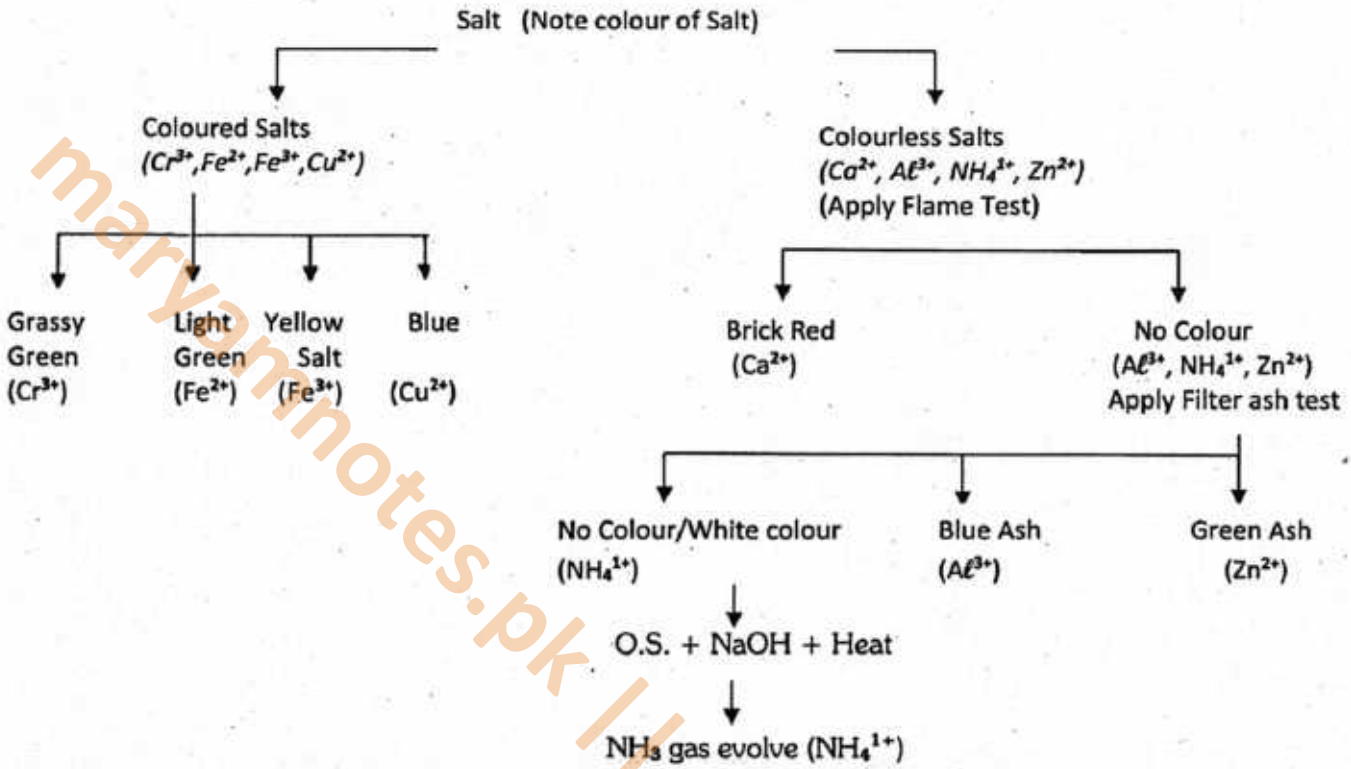
DETECTION OF CATIONS (BASIC RADICALS)

SALT ANALYSIS SCHEME FOR BASIC RADICALS



SHORT SCHEME FOR DETECTION /CONFIRMATION OF BASIC RADICALS

CATION	REACTION WITH NaOH (aq)	REACTION WITH NH_4OH (aq)	CONFIRMATORY TEST
Copper (II) (Cu^{2+})	Blue ppt., insoluble in excess	Blue ppt., soluble in excess giving dark blue solution	O.S. + $K_4[Fe(CN)_6]$ Chocolate brown ppt.
Chromium (III) (Cr^{3+})	Green ppt. soluble in excess giving dark green solution	Green ppt., insoluble in excess	O.S. + Na_3PO_4 solution Pale green ppt.
Iron (II) (Fe^{2+})	Green ppt., insoluble in excess	Green ppt., insoluble in excess	O.S. + $K_3[Fe(CN)_6]$ sol. Blue ppt. formed
Iron (III) (Fe^{3+})	Red brown ppt. Insoluble in excess	Red brown ppt., insoluble in excess	O.S. + KSCN solution Blood red coloration
Calcium (II) (Ca^{2+})	White ppt., slightly soluble in excess.	No ppt.	Brick red flame
Zinc (II) (Zn^{2+})	White ppt., soluble in excess	White ppt., soluble in excess	Green ash by filter ash test
Ammonium (NH_4^+)	NH_3 produced on heating with NaOH which gives dense white fumes with HCl	-	O.S. +picric acid+ shake Yellow needle like ppt.
Aluminum (III) ($Aℓ^{3+}$)	White ppt., soluble in excess	White ppt., insoluble in excess	O.S. + Na_3PO_4 solution White ppt.

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Experiment 8-A: Coloured Salt Radicals

Copper (Cu^{2+})

Sr. No.	EXPERIMENTS	OBSERVATIONS	INFERENCES
Dry Tests: Identification of Radical			
1	Colour of the salt was noted.	Blue colour	Cu^{2+} is indicated.
2	**Flame Test** Flame test was applied.	Bluish green flame appeared.	Cu^{2+} is indicated.
3	**Filter Ash Test** Filter Ash test was applied.	No characteristic ash formed.	Zn^{2+}, $A\ell^{3+}$ is absent.
Wet Tests			
4	**Confirmatory Tests**		
i)	O.S. + NaOH solution	Blue ppt formed.	Cu^{2+} is confirmed.
ii)	O.S. + NH_4OH added first in small amount and then in excess.	Blue ppt. formed soluble in excess to form deep blue colour	Cu^{2+} is confirmed.
iii)	O.S. + $K_4[Fe(CN)_6]$ solution	Chocolate brown colour ppt. formed.	Cu^{2+} is confirmed.

CHEMICAL EQUATIONS: WET TESTS

i) $CuSO_4 + 2NaOH \rightarrow Na_2SO_4 + \mathbf{Cu}(OH)_2$ ***(Blue ppt.)***

ii) $CuSO_4 + 4NH_4OH \rightarrow 4H_2O + [\mathbf{Cu}(NH_3)_4]SO_4$ ***(Blue solution)***

iii) $2CuSO_4 + K_4[Fe(CN)_6] \rightarrow 2K_2SO_4 + \mathbf{Cu_2}[Fe(CN)_6]$ ***(Chocolate brown ppt.)***

PRACTICAL BASED ASSESSMENT (PBA) TEST — Marks 03

Q **A blue solid A was analyzed. The following tests were carried out to identify the cation present. Complete the expected observations and inferences.**

(i) A student performs a flame test on solid A using a clean platinum wire. What is the colour of the flame observed? **[1]**

A small amount of A was dissolved in distilled water to prepare its aqueous solution.

(ii) To a portion of this solution, aqueous NaOH was added dropwise. What is the observation and what does it show? **[1]**

(iii) To another portion of A's solution, aqueous NH_4OH was added first in small quantity and then in excess. What is the change observed and what inference can be drawn? **[1]**

SOLUTION PRACTICAL BASED ASSESSMENT (PBA) TEST — Marks 03

(i) Bluish-green flame observed. This indicates Cu^{2+}.

(ii) Light blue precipitate of $Cu(OH)_2$ formed, insoluble in excess. This confirms Cu^{2+}.

(iii) Light blue precipitate dissolves in excess to give a deep blue solution; due to formation of $[Cu(NH_3)_4(H_2O)_2]^{2+}$. This confirms Cu^{2+}.

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Chromium (Cr^{3+})

Sr. No.	EXPERIMENTS	OBSERVATIONS	INFERENCES
Dry Tests: Identification of Radical			
1	Colour of the salt was noted.	Grassy green salt.	Cr^{3+} is indicated
2	**Flame Test**		
	Flame test was applied.	No characteristic colour of the flame appeared.	Cu^{2+}, Ca^{2+} are absent.
3	**Filter Ash Test**		
	Filter Ash test was applied.	No characteristic ash formed.	Zn^{2+}, $A\ell^{3+}$ is absent.
Wet Tests			
4	**Confirmatory Tests**		
i)	O.S. + NaOH solution	Dirty green ppt. formed, soluble in excess of NaOH.	Cr^{3+} is confirmed.
ii)	O.S. + NH_4OH solution.	Dirty green ppt. formed	Cr^{3+} is confirmed.
iii)	O.S. + Na_3PO_4 solution.	Green ppt. of $CrPO_4$	Cr^{3+} is confirmed.
iv)	O.S. + Na_2HPO_4 solution.	Green ppt. insoluble in acetic acid	Cr^{3+} is confirmed.

CHEMICAL EQUATIONS: WET TESTS

i) $CrCl_3 + 3NaOH \rightarrow 3NaCl + Cr(OH)_3$ ***(Dirty Green ppt.)***

ii) $CrCl_3 + 3NH_4OH \rightarrow 3NH_4Cl + Cr(OH)_3$ ***(Dirty Green ppt.)***

iii) $CrCl_3 + Na_3PO_4 \rightarrow 3NaCl + CrPO_4$ ***(Green ppt.)***

iv) $CrCl_3 + Na_2HPO_4 \rightarrow 2NaCl + HCl + CrPO_4$ ***(Green ppt.)***

PRACTICAL BASED ASSESSMENT (PBA) TEST — Marks 03

Q. *A solid A was analyzed. A student dissolved specific amount of A in distilled water and divided into two portions. Following table shows the tests and the student's observations for compound A.*

Tests	Observations
Test 1: Appearance of A	Grassy green colour
Test 2: An excess of aqueous sodium hydroxide was added to the first portion of solution A.	Dirty green precipitate formed, soluble in excess giving dark green solution.
Test 3: To the second portion of solution A, aqueous sodium phosphate was added and the mixture shaken.	Green precipitate formed, insoluble in dilute acetic acid.

(i) Name the cation present in solution A. **[1]**

(ii) Write down formula of the precipitate formed in test 2. **[1]**

(iii) Write down formula of the precipitate formed in test 3. **[1]**

SOLUTION PRACTICAL BASED ASSESSMENT (PBA) TEST — Marks 03

(i) Chromium(III) ion (Cr^{3+})

(ii) Chromium(III) hydroxide, $Cr(OH)_3$

(iii) Chromium(III) phosphate, $CrPO_4$

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Ferrous (Fe^{2+})

Sr. No.	EXPERIMENTS	OBSERVATIONS	INFERENCES
Dry Tests: Identification of Radical			
1	Colour of the salt was noted.	Light green salt.	Fe^{2+} is indicated.
2	**Flame Test**		
	Flame test was applied.	No characteristic colour of flame appeared.	Cu^{2+}, Ca^{2+} are absent.
3	**Filter Ash Test**		
	Filter Ash test was applied.	No characteristic ash formed.	Zn^{2+} , $A\ell^{3+}$ is absent.
Wet Tests			
4	**Confirmatory Tests**		
i)	O.S. + NaOH solution	Greenish white ppt. formed.	Fe^{2+} is confirmed.
ii)	O.S. + NH_4OH solution.	Greenish white ppt. formed.	Fe^{2+} is confirmed.
iii)	O.S. + $K_3[Fe(CN)_6]$	Blue ppt. formed	Fe^{2+} is confirmed.
iv)	O.S. + Na_2CO_3 solution	White ppt. of $FeCO_3$ formed.	Fe^{2+} is confirmed.

CHEMICAL EQUATIONS: WET TESTS

i) $FeSO_4 + 2NaOH \rightarrow Na_2SO_4 + Fe(OH)_2$ *(Greenish white ppt.)*

ii) $FeSO_4 + 2NH_4OH \rightarrow (NH_4)_2SO_4 + Fe(OH)_2$ *(Greenish white ppt.)*

iii) $FeSO_4 + 2K_3[Fe(CN)_6] \rightarrow 3K_2SO_4 + Fe_3[Fe(CN)_6]$ *(Blue ppt.)*

iv) $FeSO_4 + Na_2CO_3 \rightarrow Na_2SO_4 + FeCO_3$ *(White ppt.)*

PRACTICAL BASED ASSESSMENT (PBA) TEST Marks 03

Q. ***A solid A was analyzed. It was a ferrous salt. Tests were done on A. Complete the expected observations.***

(i) A student heats a small amount of A on a clean platinum wire in a Bunsen flame after moistening it with dilute HCl. What is observed? **[1]**

(ii) A was dissolved in distilled water. To the solution, aq. NaOH was added till no further change occurred. The mixture was left to stand for a while. Write the observation and equation **[1]**

(iii) A fresh portion of the same solution was treated with a few drops of potassium ferricyanide solution. What is the colour of the precipitate formed? **[1]**

SOLUTION PRACTICAL BASED ASSESSMENT (PBA) TEST Marks 03

(i) No characteristic flame colour appeared.

(ii) Greenish white precipitate formed which slowly turned brown on standing due to oxidation of Fe^{2+} to Fe^{3+}.

$FeSO_4 + 2NaOH \rightarrow Na_2SO_4 + Fe(OH)_2$ *(Greenish white ppt.)*

(iii) Blue precipitate obtained.

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Ferric (Fe^{3+})

Sr. No.	EXPERIMENTS	OBSERVATIONS	INFERENCES
Dry Tests: Identification of Radical			
1	Colour of the salt was noted.	Yellow salt.	Fe^{3+} is indicated.
2	**Flame Test**		
	Flame test was applied.	No characteristic colour of flame appeared.	Cu^{2+}, Ca^{2+} are absent.
3	**Filter Ash Test**		
	Filter Ash test was applied.	No characteristic ash formed.	Zn^{2+} , $A\ell^{3+}$ is absent.
Wet Tests			
4	**Confirmatory Tests**		
i)	O.S. + KSCN solution	Blood red colouration formed.	Fe^{3+} is confirmed.
ii)	O.S. + Na_3PO_4 solution	Yellow ppt. formed of $FePO_4$	Fe^{3+} is confirmed.
iii)	O.S. + $K_4[Fe(CN)_6]$ solution	Prussian blue ppt. formed.	Fe^{3+} is confirmed.
iv)	O.S. + NaOH solution	Reddish brown ppt. formed.	Fe^{3+} is confirmed.
v)	O.S. + NH_4OH solution.	Reddish brown ppt. formed.	Fe^{3+} is confirmed.

CHEMICAL EQUATIONS: WET TESTS

i) $FeCl_3 + 3KSCN \rightarrow 3KCl + Fe(SCN)_3$ ***(Blood red coloration)***

ii) $FeCl_3 + Na_3PO_4 \rightarrow 3NaCl + FePO_4$ ***(Yellow ppt.)***

iii) $4FeCl_3 + 3K_4[Fe(CN)_6] \rightarrow 12KCl + Fe_4[Fe(CN)_6]_3$ ***(Prussian blue ppt.)***

iv) $FeCl_3 + 3NaOH \rightarrow 3NaCl + Fe(OH)_3$ ***(Reddish brown ppt.)***

v) $FeCl_3 + 3NH_4OH \rightarrow 3NH_4Cl + Fe(OH)_3$ ***(Reddish brown ppt.)***

PRACTICAL BASED ASSESSMENT (PBA) TEST — Marks 03

(i) A student observed the colour of an unknown salt A before performing any test. The salt appeared yellow. What does this colour indicate about the cation present? **[1]**

Specific amount of A was added to distilled water to prepare its aqueous solution.

(ii) When NaOH solution was added dropwise to a portion of the solution of A, a precipitate appeared that remained undissolved in excess. State the observation and inference. **[1]**

(iii) A portion of aqueous solution of A was treated with a few drops of KSCN solution. State the observation and the inference. **[1]**

SOLUTION PRACTICAL BASED ASSESSMENT (PBA) TEST — Marks 03

(i) The yellow colour of the salt indicates the presence of Fe^{3+} ions.

(ii) Reddish brown precipitate of $Fe(OH)_3$ formed, insoluble in excess. This confirms Fe^{3+} ions.

(iii) Blood red colouration appeared. This confirms the presence of Fe^{3+} ions.

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VIVA VOCE

Q. 1 What happens when $K_4[Fe(CN)_6]$ is added to copper salt solution?

Ans A chocolate red ppt. of $Cu_2[Fe(CN)_6]$ are formed.

$$2Cu^{2+} + K_4[Fe(CN)_6] \longrightarrow Cu_2[Fe(CN)_6] + 4K^+.$$

chocolate red ppt.

Q. 2 How Fe^{2+} and Fe^{3+} can be identified?

Ans Both can be identified by the colour of the salt.

(i) The colour of Fe^{2+} salt is green while that of Fe^{3+} is yellow in colour.

(ii) When NaOH solution is added to the salt solution then Fe^{2+} gives green ppt. while Fe^{3+} gives reddish brown ppt.

$$Fe^{2+} + 2NaOH \rightarrow Fe(OH)_2 + 2Na^+$$

(Green ppt.)

$$Fe^{3+} + 3NaOH \rightarrow Fe(OH)_3 + 3Na^+$$

(Reddish Brown ppt.)

Q. 3 What is the colour of chromium salts?

Ans Dark green

Q. 4 What is the colour of ferrous salts?

Ans Light green

Q. 5 What is the colour of ferric salts?

Ans Yellow

Q. 6 What is the colour of copper salts?

Ans Blue

Q. 7 What is the formula of Potassium ferrocyanide and potassium ferricyanide?

Ans Potassium ferrocyanide: $K_4[Fe(CN)_6]$

Potassium ferricyanide: $K_3[Fe(CN)_6]$

Q. 8 What is the formula for the following (i) Sodium cobaltinitrite (ii) Potassium pyrantimonate

Ans (i) Sodium cobaltinitrite $Na_3[Co(NO_2)_6]$

(ii) Potassium pyrantimonate $K_2H_2Sb_2O_7$

Q. 9 Write the name of $Cu_2[Fe(CN)_6]$.

Ans: Copper hexacyanoferrate (II)

Q. 10 What happens when excess ammonium hydroxide is added to O.S of Cu^{2+}?

Ans : When ammonium hydroxide is added to O.S of Cu^{2+} in small amount blue ppt. are formed. When excess NH_4OH solution is added, blue ppt. becomes soluble and form deep blue color solution.

Q. 11 What happens when sodium hydroxide solution is added to copper sulphate solution?

Ans : $Cu^{2+} + 2NaOH \rightarrow Cu(OH)_2 + 2Na^+$

(Blue ppt.)

Q. 12 When copper salt is subjected to flame test, which colour appears?

Ans : Blue

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PRACTICAL BASED ASSESSMENT (PBA) TEST-1 Marks 06

Q Two solids 'A' and 'B' were analyzed. A was Chromium(III) salt and B was a sulphate salt. Following tests were performed.

(a) Tests on A.

(i) A student notes the colour of solid 'A' placed in a watch glass. What colour is observed? **[1]**

Specific amount of A was added to distilled water to prepare its solution in a test-tube. Divide A into two equal portions in two test-tubes.

(ii) To the first portion, add aqueous NaOH dropwise, then in excess. Write your observations. **[1]**

(iii) To the second portion, add aq. NH_4OH dropwise then in excess. Write your observations. **[1]**

(b) Tests on B

A specific amount of B was added to distilled water and divided into two portions. The following table shows the tests and the student's observations for compound B.

Tests	Observations
Test 1: Appearance of B	Light green colour.
Test 2: Aqueous sodium hydroxide was added in excess to the first portion of solution B.	Greenish white precipitate formed, turning brown on standing.
Test 3: To the second portion of solution B, a few drops of potassium ferricyanide solution were added.	A blue precipitate was formed.

(i) Name the cation present in solution B. **[1]**

(ii) Write down the formula of the precipitate formed in Test 2. **[1]**

(iii) Write the name and formula of compound B **[1]**

SOLUTION PRACTICAL BASED ASSESSMENT (PBA) TEST-1 Marks 06

(a) Test on A

(i) Grassy green colour observed.

(ii) Dirty green precipitate formed, soluble in excess of NaOH giving a dark green solution.

(iii) Dirty green precipitate formed, insoluble in excess of NH_4OH.

(b) Test on B

(i) Ferrous (Fe^{2+})

(ii) $Fe(OH)_2$

(iii) Ferrous sulphate ($FeSO_4$)

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PRACTICAL BASED ASSESSMENT (PBA) TEST-2 Marks 06

Q Two solids 'A' and 'B' were analyzed. Following tests were performed.

(a) Tests on A

*A student observed the colour of an unknown salt A before performing any test. The salt appeared yellow. Specific amount of **A** was added to distilled water to prepare its aqueous solution.*

(i) The aqueous solution of A was treated with NH_4OH solution. A precipitate appeared similar in colour to that obtained with NaOH. What does this similarity in reaction indicate? **[1]**

(ii) A student added $K_4[Fe(CN)_6]$ solution to a portion of the aqueous solution of A. What is the observation, and what does it confirm? **[1]**

(iii) To a portion of A's solution, a few drops of Na_3PO_4 were added and the mixture was warmed. State the observation and inference. **[1]**

(a) Tests on B

A specific amount of B was added to distilled water and divided into two portions. The following table shows the tests and the student's observations for compound B.

Tests	Observations
Test 1: Appearance of B	Blue-green crystalline solid
Test 2: Aqueous sodium hydroxide was added in excess to the first portion of solution B	Blue precipitate formed, turning deep blue on standing in excess NaOH
Test 3: To the second portion of solution B, a few drops of potassium ferrocyanide $[K_4Fe(CN)_6]$ solution were added	Chocolate brown precipitate formed

(i) Name the cation present in solution B. **[1]**

(ii) Write down the formula of the precipitate formed in Test 2. **[1]**

(iii) Write the formula of chocolate brown ppt formed in Test 3. **[1]**

SOLUTION PRACTICAL BASED ASSESSMENT (PBA) TEST-2 Marks 06

(a) Tests on A

(i) Reddish brown $Fe(OH)_3$ formed with both reagents, confirming the presence of Fe^{3+} ions.
(ii) Deep blue precipitate (Prussian blue) formed. This confirms Fe^{3+} ions.
(iii) Yellow precipitate of $FePO_4$ formed. This indicates Fe^{3+} ions.

(b) Tests on B

(i) Copper (Cu^{2+})
(ii) $Cu(OH)_2$: The reaction is; $CuSO_4 + 2NaOH \rightarrow Na_2SO_4 + Cu(OH)_2$ ***(Blue ppt.)***
(iii) Chocolate brown ppt: $Cu_2[Fe(CN)_6]$

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Experiment 8-B: Colourless Salt Radicals

Calcium (Ca^{2+})

Sr. No.	EXPERIMENTS	OBSERVATIONS	INFERENCES
Dry Tests: Identification of Radical			
1	Colour of salt was noted.	Salt was white.	Coloured salts (Cu^{2+}, Fe^{2+}, Fe^{3+}, Cr^{3+}) are absent.
2	**Flame Test** Flame test was applied.	Brick Red flame appeared.	Ca^{2+} is indicated
3	**Filter Ash Test** Filter ash test was applied.	No characteristic ash formed.	Zn^{2+} , $A\ell^{3+}$ is absent.
Wet Tests			
4	**Confirmatory Tests**		
i)	O.S + NaOH solution	White ppt. formed	Ca^{2+} is confirmed.
ii)	O.S + $NH_4Cl_{(s)}$ + $K_4[Fe(CN)_6]$	White ppt. formed	Ca^{2+} is confirmed.
iii)	O.S + dil. H_2SO_4 solution.	White ppt. formed	Ca^{2+} is confirmed.
iv)	O.S + Na_3PO_4 solution.	White ppt. formed	Ca^{2+} is confirmed.

CHEMICAL EQUATIONS: WET TESTS

i) $CaCl_2 + 2NaOH \rightarrow 2NaCl + Ca(OH)_2$ *(White ppt.)*

ii) $2CaCl_2 + K_4[Fe(CN)_6] \rightarrow 4KCl + Ca_2[Fe(CN)_6]$ *(White ppt.)*

iii) $CaCl_2 + H_2SO_4 \rightarrow 2HCl + CaSO_4$ *(White ppt.)*

iv) $3CaCl_2 + 2Na_3PO_4 \rightarrow 6NaCl + Ca_3(PO_4)_2$ *(White ppt.)*

PRACTICAL BASED ASSESSMENT (PBA) TEST — Marks 03

(i) A portion of solid salt B was exposed to a Bunsen flame and a brick-red (orange-red) flame appeared. What does this observation indicate about the cation present? **[1]**

A specific amount of A was added to distilled water and following tests were performed.

Tests	Observations
Test 1: Aqueous sodium hydroxide was added in excess to the first portion of solution B.	White precipitate formed, insoluble in excess NaOH.
Test 2: Dilute sulfuric acid was added to the second portion of solution B.	White turbidity appeared.

(ii) What inference can be drawn from the formation of a white precipitate that remains insoluble in excess NaOH? Give reaction. **[1]**

(iii) Why does the addition of dilute H_2SO_4 produce a white turbidity in the second portion? **[1]**

SOLUTION PRACTICAL BASED ASSESSMENT (PBA) TEST — Marks 03

(i) Brick-red flame indicates the presence of Ca^{2+} ions.

(ii) This shows cation forms an insoluble hydroxide. $CaCl_2 + 2NaOH \rightarrow 2NaCl + Ca(OH)_2$. It confirms Ca^{2+} ions.

(iii) Due to formation of sparingly soluble $CaSO_4$. This confirms presence of Ca^{2+} ions.

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Zinc (Zn^{2+})

No.	EXPERIMENTS	OBSERVATIONS	INFERENCES
Dry Tests: Identification of Radical			
1	Colour of salt was noted.	White salt.	Coloured salts (Cu^{2+}, Fe^{2+}, Fe^{3+}, Cr^{3+}) are absent.
2	**Flame Test** Flame test was applied.	No characteristic colour of flame appeared.	Cu^{2+}, Ca^{2+} are absent.
3	**Filter Ash Test** Filter ash test was applied.	Green ash formed.	Zn^{2+} is indicated.
Wet Tests			
4	**Confirmatory Tests**		
i)	O.S. + NaOH solution	White ppt. formed soluble in excess of NaOH	Zn^{2+} is confirmed.
ii)	O.S. + NH_4OH solution.	White ppt. soluble in excess NH_4OH	Zn^{2+} is confirmed.
iii)	O.S. + $K_4[Fe(CN)_6]$ solution.	White ppt. formed	Zn^{2+} is confirmed.

CHEMICAL EQUATIONS: WET TESTS

i) $ZnCl_2 + 2NaOH \rightarrow 2NaCl + Zn(OH)_2$ *(White ppt.)*

$Zn(OH)_2 + 2NaOH \rightarrow Na_2ZnO_2 + 2H_2O$ *(Clear solution, soluble)*

ii) $ZnCl_2 + 2NH_4OH \rightarrow 2NH_4Cl + Zn(OH)_2$ *(White ppt.)*

iii) $2ZnCl_2 + K_4[Fe(CN)_6] \rightarrow 4KCl + Zn_2[Fe(CN)_6]$ *(White ppt.)*

PRACTICAL BASED ASSESSMENT (PBA) TEST Marks 03

(i) The filter ash from the salt was performed and green ash was observed. State the inference. **[1]**

(ii) To a portion of the aq. solution, NaOH was added dropwise until a precipitate first formed, then excess NaOH was added. State the two sequential observations and the single inference. **[1]**

(iii) A fresh portion of the aqueous solution was treated with a few drops of NH_4OH; after initial precipitation an excess of NH□OH was added. State the observation and inference. **[1]**

SOLUTION PRACTICAL BASED ASSESSMENT (PBA) TEST Marks 03

(i) The green ash is characteristic for zinc salts on ignition, supporting presence of Zn^{2+}.

(ii) Initially a white precipitate of $Zn(OH)_2$ appeared. Then precipitate dissolved in excess NaOH. This shows the presence of Zn^{2+}.

(iii) A white precipitate formed which dissolved in excess NH_4OH due to the formation of an ammine complex / solubilization in excess NH_3. This confirms Zn^{2+} ions.

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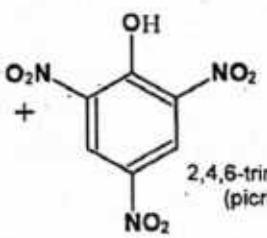
Ammonium (NH_4^{1+})

Sr. No.	EXPERIMENTS	OBSERVATIONS	INFERENCES
Dry Tests			
1	Colour of salt was noted.	Salt was white.	Coloured salts (Cu^{2+}, Fe^{2+}, Fe^{3+}, Cr^{3+}) are absent.
2	**Flame Test** Flame test was applied.	No characteristic colour of the flame appeared.	Cu^{2+}, Ca^{2+} are absent.
3	**Filter Ash Test** Filter ash test was applied.	No characteristic ash formed.	Zn^{2+}, $A\ell^{3+}$ is absent. NH_4^+ may be present
	Identification of Radical ***(Wet Test)***		
4	O.S + NaOH + heat	NH_3 gas is evolved, give dense white fumes with rod dipped in conc. HCl	NH_4^+ is indicated.
Wet Tests			
5	**Confirmatory Tests**		
i)	O.S + Nessler's reagent (K_2HgI_4)	Brown ppt. formed.	NH_4^+ is confirmed.
ii)	O.S + picric acid solution.	Yellow needle like crystals formed.	NH_4^+ is confirmed.
iii)	O.S + acetic acid and sodium cobaltnitrite solution.	Yellow ppt. formed.	NH_4^+ is confirmed.

CHEMICAL EQUATIONS: WET TESTS

4. $NH_4Cl + NaOH \rightarrow NaCl + H_2O + NH_3$ ***(Smell of ammonia)***

i) $NH_4^{1+} + K_2HgI_4 + OH^- \rightarrow 2H_2O + NH_2.Hg_2I_3$ ***(Brown ppt.)***

ii) NH_4^{1+} +  → H^+ +

2,4,6-trinitrophenol (picric acid)

Ammonium picrate (Yellow ppt.)

iii) $3NH_4^{1+} + Na_3\{Co(NO_2)_4\} \rightarrow 3NaCl + (NH_4)_3[Co(NO_2)_6]$ ***(Yellow ppt.)***

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PRACTICAL BASED ASSESSMENT (PBA) TEST Marks 03

Q. The following table shows the tests and the student's observations for compound D.

Tests	Observations
Test 1 – Colour of salt and filter ash test	Salt is white. No characteristic ash is formed.
Test 2 – To the first portion of the aqueous solution of D, aqueous NaOH was added and the mixture was heated.	A colourless gas evolved which turned moist red litmus paper blue.
Test 3 – Nessler's reagent was added to the second portion of solution D.	A brown precipitate was formed.

(i) What inference can be drawn from the observation in Test 2? Write the corresponding equation **[1]**

(ii) What inference can be drawn from the result of Test 3? **[1]**

(iii) The test 1 shows that the salt was white and gave no flame colour in the flame test. State the inference. **[1]**

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SOLUTION PRACTICAL BASED ASSESSMENT (PBA) TEST Marks 03

(i) The gas is ammonia (NH_3), indicating the presence of NH_4^+.

$$\mathbf{NH_4Cl} + NaOH \rightarrow NaCl + H_2O + \mathbf{NH_3}$$

(ii) The brown precipitate with Nessler's reagent confirms the presence of ammonium ions (NH_4^+).

(iii) The white salt indicates the absence of coloured cations like Cu^{2+}, Fe^{2+}, Fe^{3+}, Cr^{3+}.
The absence of a flame colour indicates that Cu^{2+}, Ca^{2+} are absent.

Aluminium ($A\ell^{3+}$)

No.	EXPERIMENTS	OBSERVATIONS	INFERENCES
Dry Tests			
1	Colour of salt was noted.	White colour	Coloured salts (Cu^{2+}, Fe^{2+}, Fe^{3+}, Cr^{3+}) are absent.
2	**Flame Test** Flame test was applied.	No characteristics colour of flame appeared.	Cu^{2+}, Ca^{2+} are absent.
3	**Filter Ash Test** Filter Ash test was applied.	Blue ash formed.	$A\ell^{3+}$ may be present
	Identification of Radical *(Wet Test)*		
4	O.S + NaOH	White ppt. of $Al(OH)_3$ formed, soluble in excess of NaOH	$A\ell^{3+}$ is indicated.
Wet Tests			
5	**Confirmatory Tests**		
i)	O.S + 1-2 drops of litmus solution + HCl + NH_4OH in excess.	A blue lake formed (white ppt. of $Al(OH)_3$ with adsorbed dye in colourless soln.)	$A\ell^{3+}$ is confirmed
ii)	O.S. + Na_3PO_4 solution.	White ppt. soluble in HCl.	$A\ell^{3+}$ is confirmed

CHEMICAL EQUATIONS: WET TESTS

4 $AlCl_3 + 3NaOH \rightarrow 3NaCl + Al(OH)_3$ *(White ppt.)*

i) $AlCl_3 + 3NH_4OH \rightarrow 3NH_4Cl + Al(OH)_3$ *(White ppt.)*

ii) $AlCl_3 + Na_3PO_4 \rightarrow 3NaCl + AlPO_4$ *(White ppt.)*

PRACTICAL BASED ASSESSMENT (PBA) TEST Marks 03

(i) The colour of an unknown salt B was noted before performing any test. The salt appeared white. What does this observation suggest about the possible cation? [1]

(ii) To a portion of B's solution, Na_3PO_4 was added. A precipitate formed. What is the observation and inference? [1]

(iii) A portion of B's solution was treated with litmus solution, followed by a few drops of HCl and then NH_4OH in excess. A coloured lake appeared. State the observation and inference. [1]

SOLUTION PRACTICAL BASED ASSESSMENT (PBA) TEST Marks 03

(i) The white colour indicates that coloured cations like Fe^{2+}, Fe^{3+}, Cu^{2+}, Cr^{3+} are absent.

(ii) White ppt. of $AlPO_4$ formed, which confirms the presence of Al^{3+} ions.

(iii) A blue lake appeared in a colourless solution, confirming the presence of Al^{3+} ions.

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VIVA VOCE

Q. 1 What are the colours of the salts of following cations. NH_4^+ , Zn^{2+}?
Ans NH_4^+ White Zn^{2+} White

Q. 2 What happens when K_2CrO_4 solution is added to Pb^{2+} salt solution?
Ans Yellow ppt. of $PbCrO_4$ formed.

$$Pb^{2+} + K_2CrO_4 \longrightarrow \underset{\text{Yellow ppt.}}{PbCrO_4} + 2K^+.$$

Q. 3 What happens when potassium ferro cyanide solution is added to zinc salt solution?
Ans White ppt. Formed

$$Zn^{2+}_{(aq)} + K_4[Fe(CN)_6](aq) \longrightarrow Zn_2[Fe(CN)_6] + 4K^+_{(aq)}$$

Q. 4 What colour is imparted to the flame by Ca^{2+} and Zn^{2+} ?
Ans Ca^{2+} Brick Red Zn^{2+} No characteristic flame

Q. 5 Which radical gives yellow ppt. with K_2CrO_4?
Ans Barium

Q. 6 When ammonium salts are heated with NaOH which gas is evolved? How is it identified?
Ans NH_3 gas is evolved. It gives dense white fumes with the glass rod dipped in HCl.

$$NH_3 + HCl \rightarrow NH_4Cl \text{ (white fumes)}$$

Q. 7 What is the formula of Nessler's reagent?
Ans Nessler's reagent K_2HgI_4

Q. 8 What is the colour of ash produced during filter ash test of Zinc radical?
Ans green ash

Q. 9 Which colour is imparted to flame by Al^{3+}?
Ans No colour

Q. 10 What is the formula of ash formed in filter ash test of Zinc radical?
Ans ZnO.CoO

Q. 11 Write two confirmatory tests of Zn^{2+}

No.	Experiment	Observation	Inference
i)	O.S. + NaOH solution	White ppt. formed soluble in excess of NaOH.	Zn^{2+} is confirmed.
ii)	O.S. + $K_4[Fe(CN)_6]$ solution.	White ppt. formed.	Zn^{2+} is confirmed.

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PRACTICAL BASED ASSESSMENT (PBA) TEST-1 Marks 06

Q A student performed following tests on solid 'A' and solid 'B'

(a) Tests on A

(i) When the salt A is subjected to flame test, it gives brick red flame. Which cation is indicated? **[1]**

(ii) When the salt A is treated with conc. NaOH solution, white ppt. are formed. Write formula of these ppt. **[1]**

(iii) Give one confirmatory test for the radical indicated in (i). **[1]**

(b) Tests on B

The following table shows the tests and the student's observations for compound B.

Tests	Observations
Test 1: Colour of salt	White.
Test 2: Filter-ash test	Green ash.
Test 3: To the first portion of the aqueous solution of C, aq. NaOH was added and then excess NaOH was added.	A white precipitate formed which dissolved in excess NaOH.

(i) What inference can be drawn from the colour of the salt and the filter-ash test? **[1]**

(ii) Write the formula of the precipitate formed in Test 3 **[1]**

(iii) Give the equations for test 3 **[1]**

SOLUTION PRACTICAL BASED ASSESSMENT (PBA) TEST-1 Marks 06

(a) Tests on A

(i) Ca^{2+} salts give brick red flame

(ii) $Ca(OH)_2$

(iii)

No.	Experiment	Observation	Inference
i)	O.S + dil. H_2SO_4 solution.	White ppt. of $CaSO_4$ formed	Ca^{2+} is confirmed.

(b) Tests on B

(i) The white salt indicates that coloured cations (Cu^{2+}, Fe^{2+}, Fe^{3+}, Cr^{3+}) are absent. The formation of green ash in filter ash test suggests the presence of Zn^{2+}.

(ii) Precipitate: $Zn(OH)_2$.

(iii) Formation of ppt.: $\mathbf{Zn}Cl_2 + 2NaOH \rightarrow 2NaCl + \mathbf{Zn}(OH)_2$ ***(White ppt.)***

Dissolution in excess $\mathbf{Zn}(OH)_2 + 2NaOH \rightarrow Na_2\mathbf{Zn}O_2 + 2H_2O$ ***(Clear solution, soluble)***

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PRACTICAL BASED ASSESSMENT (PBA) TEST-2 Marks 06

Q. A student noted the colour of an unknown salt A as "white." He then performed following tests.

(a) Tests on A

(i) The salt A when heated with NaOH solution evolves a gas with pungent smell and which turns red litmus blue? State the inference and the gas evolved **[1]**

(ii) What happens when a rod dipped in conc. HCl is placed on the mouth of test tube in test (i). **[1]**

(iii) A fresh portion of the solution was treated with Nessler's reagent. State the observation and inference **[1]**

(b) Tests on B

The following table shows the tests and the student's observations for compound B. He prepared an aqueous solution of the given salt 'B' and divided into two portions and performed following tests.

Tests	Observations
Test 1: Colour of salt, filter ash test and flame test	Salt is white. Blue ash and flame is formed.
Test 2: To a portion of the aqueous solution of A, NaOH solution was added dropwise.	A white precipitate formed, which dissolved in excess NaOH.
Test 3: To a portion of solution A, a few drops of litmus solution were added, then HCl and then NH_4OH in excess.	A blue lake appeared in the colourless solution.

(i) What inference can be drawn from the observation in Test 1? **[1]**

(ii) What inference can be drawn from the observation in Test 2? Write equation. **[1]**

(iii) What inference can be drawn from the observation in Test 3? **[1]**

SOLUTION PRACTICAL BASED ASSESSMENT (PBA) TEST-2 Marks 06

(a) Tests on A

(i) Colourless gas NH_3 is evolved, turned moist red litmus blue. This confirms the presence of NH_4^+ ions.

$$\mathbf{NH_4Cl} + NaOH \rightarrow NaCl + H_2O + \mathbf{NH_3}$$

(ii) White fumes of NH_4Cl are observed.

$$NH_3 + HCl \rightarrow NH_4Cl$$

(iii) A brown precipitate of $NH_2.Hg_2I_3$ formed. This confirms the presence of $\mathbf{NH_4^+}$ ions.

(b) Tests on B

(i) White salt shows absence of coloured cations (Fe^{2+}, Fe^{3+}, Cu^{2+}, Cr^{3+}), No characteristics flame shows the absence of flame-active cations (Ca^{2+}, Cu^{2+}). Blue ash shows $A\ell^{3+}$ cation.

(ii) Formation of white ppt. soluble in excess NaOH indicates Al^{3+} or Zn^{2+}.

$$AlCl_3 + 3NaOH \rightarrow 3NaCl + Al(OH)_3 \quad \textit{(White ppt.)}$$

(iii) Formation of a blue lake confirms the presence of Al^{3+} ions.

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SECTION A 60% : Marks 18

PRACTICAL BASED ASSESSMENT (PBA) TESTS WITH SOLUTIONS:

PRACTICAL BASED ASSESSMENT (PBA) TEST-1 Marks 18

Q No.1. Two solids A and B were analyzed. A was Copper(II) sulfate. Tests were done on A and B.

(a) Tests on A

(i) A student performs a flame test on A. What is the flame colour observed?

(ii) A specific amount of A was added to distilled water to prepare its solution. To the first portion, add aqueous sodium hydroxide dropwise, then in excess. Write the observation.

(i) To the second portion of solution A, add aqueous ammonia dropwise, then in excess. Write the observation.

(b) Tests on B

Specific amount of B was added to distilled water to prepare its solution. Students divided this solution into two portions.

Tests	Observations
Test 1: Appearance of B	Yellow-brown solid
Test 2: Aqueous sodium hydroxide was added to the first portion of solution B.	Reddish-brown precipitate formed which remains insoluble in excess of sodium hydroxide.
Test 3: Aqueous potassium thiocyanate was added to the second portion of solution B.	Blood-red solution formed.

(i) Name the cation present in solution B.

(ii) Write down formula of the precipitate formed in Test 2.

(iii) Why blood red solution formed in Test 3.

Q No.2.A 0.025 M potassium hydrogen carbonate (KHCO3) solution was titrated against *dilute* sulfuric acid (H2SO4) using methyl orange. 25.0 cm³ of the KHCO3 solution required 12.5 cm³ of the acid for complete neutralization.

(a) Predict the initial and final colours of the titration mixture. **[1]**

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(b) Write the balanced equation for the neutralization reaction. **[1]**

(c) Calculate the molarity of H_2SO_4 used in the titration. **[2]**

(d) Determine the volume of this acid needed to prepare 1 dm^3 of 0.01 M H_2SO_4. **[2]**

Q No.3. A student performs a redox titration between acidified potassium permanganate and hydrated oxalic acid in the presence of dilute sulfuric acid. The reaction occurring is:

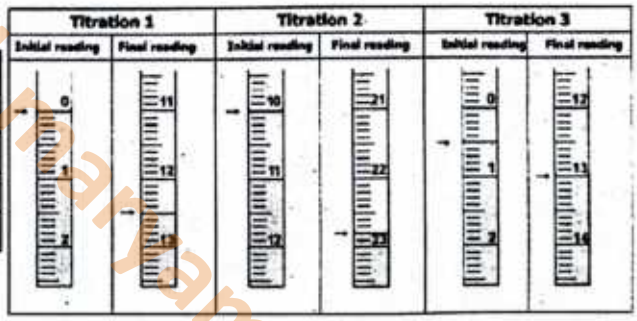
$$2KMnO_4 + 5H_2C_2O_4.2H_2O + 3H_2SO_4 \rightarrow K_2SO_4 + 2MnSO_4 + 18H_2O + 10CO_2$$

During the titration, 0.020 M $KMnO_4$ solution was used to completely react with 25.0 cm^3 of oxalic acid solution.

(a) See on the figure given below and record the observations in table **[2]**

Observation Table:

Titration number	1	2	3
Final Reading (cm^3)			
First Reading (cm^3)			
Volume of $KMnO_4$ used (cm^3)			
Best titration result (✓)			



Mean volume of $KMnO_4$ used = _____ cm^3

(b) State the role of sulfuric acid in this reaction. **[1]**

(c) What colour change indicates the end point? **[1]**

(d) Find the molarity of the oxalic acid solution. **[2]**

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PRACTICAL BASED ASSESSMENT (PBA) TEST-2 Marks 18

Q No.1. Two solids A and B were analyzed. Tests were done on A and B.

(a) Tests on A

A was Sodium carbonate.

(i) A small amount of A was added to dilute sulphuric acid. What is the observation? **[1]**

(ii) A solution of A was prepared. To a portion of it, magnesium sulfate solution was added. Write its observation. **[1]**

(iii) On the basis of test (i) and (ii); indicate the radical? **[1]**

(b) Tests on B

B contains chloride ions

Tests	Observations
Test 1: Filter ash test	Green ash formed
Test 2: Aqueous sodium hydroxide was added to the first portion of solution B.	White precipitate formed which dissolves in excess sodium hydroxide.
Test 3: Aqueous ammonia was added to the second portion of solution B.	White precipitate forms which dissolves in excess ammonia solution.

(i) Name the cation present in solution B. **[1]**

(ii) Write down formula of the precipitate formed in Test 2. **[1]**

(iii) Write the name of B. **[1]**

Q No.2. A pure sample of Mohr's salt, was analyzed to determine its exact formula. The compound is known to contain both Fe^{2+} ions and ammonium sulfate, and its general formula may be written as: $FeSO_4.(NH_4)_2SO_4.xH_2O$, where x is an unknown whole number. A student prepared a solution by dissolving 39.2 g of the salt in water and making the total volume up to 1.00 dm^3. This was labelled solution B. To determine x, 15.0 cm^3 of this solution was acidified with dilute sulfuric acid and titrated with 0.0200 M potassium manganate(VII) solution, solution A.

(a) What was the colour change at the end point? **[1]**

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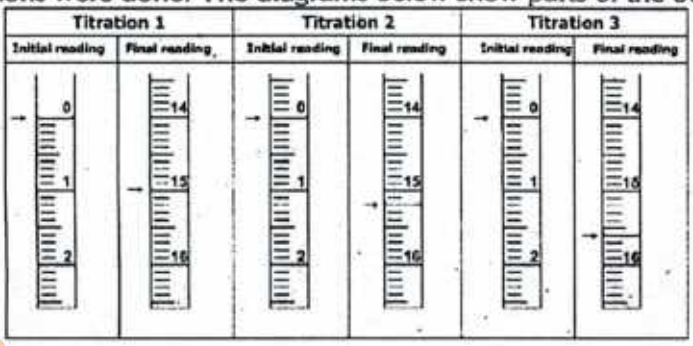
(b) Three titrations were done. The diagrams below show parts of the burette before and after each titration



Use these diagrams to complete the table of results.

Titration number	1	2	3
Final reading (cm^3)			
First reading (cm^3)			
Volume of solution A used			
Best titration result (✓)			

Tick (✓) the best titration results. Using these results, the average volume of A ---------- cm^3.

When acidified $KMnO_4$ reacts with Mohr's salt the following reaction occurs:

$$2KMnO_4 + 10FeSO_4.(NH_4)_2SO_4.xH_2O + 8H_2SO_4 \rightarrow K_2SO_4 + 2MnSO_4 + 5Fe_2(SO_4)_3 + 10(NH_4)_2SO_4 + (10x+8)H_2O$$

(c) Calculate molarity of Mohr's salt by using the chemical equation and above data. **[2]**

(d) By using your answer to (c) and the strength of Mohr's salt, calculate the value of 'x' (water of crystallization) in $FeSO_4.(NH_4)_2SO_4.xH_2O$

Q No.3. A titrimetric analysis was performed in which 20.0 cm^3 of an iodine solution was titrated against a standardized 0.100 mol dm^{-3} $Na_2S_2O_3$ solution. The equivalence point was attained after the addition of 10.0 cm^3 of titrant.

(a) Write balanced equation for the reaction between iodine and sodium thiosulfate. **[1]**

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(b) Why starch indicator is added to the solution near the end point? **[2]**

(c) Calculate the molarity of iodine solution. **[2]**

(d) Use your answer in (c) to determine the amount per dm^3 of iodine in solution? [I=127] **[1]**

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SOLUTION PRACTICAL BASED ASSESSMENT (PBA) TEST-1 Marks 18

Q No.1.

(a) Tests on A

(i) Blue-green flame is observed.

(ii) A light blue precipitate of copper(II) hydroxide forms, insoluble in excess NaOH.

$CuSO_4(aq) + 2\,NaOH(aq) \rightarrow Cu(OH)_2(s) + Na_2SO_4(aq)$.

(iii) A light blue precipitate forms which dissolves in excess ammonia to give a deep blue solution.

$Cu(OH)_2(s) + 4\,NH_3(aq) \rightarrow [Cu(NH_3)_4]^{2+}(aq) + 2\,OH^-(aq)$.

(b) Tests on B

(i) Cation present: Iron(III) ion (Fe^{3+}).

(ii) Formula of precipitate in Test 2: $Fe(OH)_3$. $FeCl_3(aq) + 3\,NaOH(aq) \rightarrow Fe(OH)_3(s) + 3\,NaCl(aq)$.

(iii) Blood red solution is due the formation of $Fe(SCN)_3$: $FeCl_3 + 3KSCN \rightarrow 3KCl + Fe(SCN)_3$ *(Blood red coloration)*

Q No.2.

(a) Initial: Yellow Final: Orange red.

(b) Equation: $2KHCO_3 + H_2SO_4 \rightarrow K_2SO_4 + H_2O + CO_2$

(c)

$$\underset{\frac{M_1\,V_1}{n_1}}{H_2SO_4} = \underset{\frac{M_2\,V_2}{n_2}}{KHCO_3}$$

$$M_1 = \frac{M_2\,V_2}{n_2} \times \frac{n_1}{V_1}$$

$$M_1 = \frac{0.025 \times 25.0}{2} \times \frac{1}{12.5} = 0.025\ M$$

(d)

Given concentration in "b" = Required concentration

$$M_1V_1 = M_2V_2$$

$$0.025 \times V_1 = 0.01 \times 1000$$

$$V_1 = \frac{0.01 \times 1000}{0.025} = 400\ cm^3$$

Measure 400 cm^3 of 0.025 M H_2SO_4 solution using a measuring cylinder. Transfer it into a 1 dm^3 volumetric flask, then add distilled water up to the mark and mix thoroughly.

Q No.3.

(a)

Titration number	1	2	3
Final Reading (cm^3)	12.5	22.8	13.0
First Reading (cm^3)	0.0	10.0	0.5
Volume of $KMnO_4$ used (cm^3)	12.5	12.8	12.5
Best titration result (✓)	✓		✓

The average volume of $KMnO_4$ used = 12.5 cm^3

(b) Sulfuric acid provides acidic medium to prevent formation of MnO_2 and ensures complete reduction to Mn^{2+}.

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(c) Endpoint: purple to colourless.

(d) According to the balanced chemical equation

Oxalic acid **$KMnO_4$**

$$\frac{M_1 V_1}{n_1} = \frac{M_2 V_2}{n_2}$$

$$M_1 = \frac{M_2 V_2}{n_2} \times \frac{n_1}{V_1}$$

$$M_1 = \frac{0.020 \times 12.5}{2} \times \frac{5}{25.0} = 0.025\ M$$

SOLUTION PRACTICAL BASED ASSESSMENT (PBA) TEST-2 Marks 18

(a) Tests on A (Sodium carbonate)

(i) Effervescence; colorless gas evolved which turns limewater milky (CO_2).

$Na_2CO_3(s) + 2\ HCl(aq) \rightarrow 2\ NaCl(aq) + H_2O(l) + CO_2(g)$.

(ii) To solution of A add magnesium sulfate: White precipitate of magnesium carbonate forms.

Equation: $Na_2CO_3(aq) + MgSO_4(aq) \rightarrow MgCO_3(s) + Na_2SO_4(aq)$.

(b) Tests on B

(i) Green ash in filter ash test shows the presence of Zn^{2+} (Zinc ion).

(ii) Formula of precipitate in Test 2: $Zn(OH)_2$.

$ZnCl_2(aq) + 2NaOH(aq) \rightarrow Zn(OH)_2(s) + 2\ NaCl(aq)$.

$Zn(OH)_2(s) + 2NaOH(aq) \rightarrow Na_2Zn(OH)_4$.

(iii) Name of B: **Zinc chloride ($ZnCl_2$)**.

$Zn(OH)_2(s) + 4\ NH_3(aq) \rightarrow [Zn(NH_3)_4]^{2+}(aq) + 2OH^-(aq)$.

Q No.2. **(a)** At the endpoint, the colour changes from Purple to very light pink or just colourless

(b)

Titration number	1	2	3
Final reading (cm^3)	15.0	15.2	15.6
First reading (cm^3)	0.0	0.0	0.0
Volume of solution $KMnO_4$ used	15.0	15.2	15.6
Best titration result (✓)	✓	✓	

The average volume of A $= \frac{15.0 + 15.2}{2} = 15.1\ cm^3$

(c) **$FeSO_4.(NH_4)_2SO_4.xH_2O$** **$KMnO_4$**

$$\frac{M_1 V_1}{n_1} = \frac{M_2 V_2}{n_2}$$

$$M_1 = \frac{M_2 V_2}{n_2} \times \frac{n_1}{V_1}$$

$$M_1 = \frac{0.0200 \times 15.1}{2} \times \frac{10}{15.0}$$

$$M_1 = 0.101\ M$$

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(d) Given mass of $FeSO_4.(NH_4)_2SO_4.xH_2O$ dissolved per dm^3 = 39.2 g

Molar mass of $FeSO_4.(NH_4)_2SO_4.xH_2O$ = 56 + 32×2 +16×8 +1×8 +14×2 + 18x

= 284 + 18x

Mass of $FeSO_4.(NH_4)_2SO_4.xH_2O$ per dm^3 = Molarity (M_1) × Molar mass of $FeSO_4.(NH_4)_2SO_4.xH_2O$

$$39.2 = 0.101 \times (284 + 18x)$$

$$284 + 18x = \frac{39.2}{0.101}$$

$$284 + 18x = 388$$

$$18x = 388 - 284$$

$$18x = 104$$

$$x = \frac{104}{18} = 5.77 \approx \mathbf{6}$$

Q No.3.

(a) $2Na_2S_2O_3.5H_2O + I_2 \rightarrow Na_2S_4O_6 + 2NaI + 10H_2O$

(b) Because iodine forms a deep blue complex with starch. If added too early, the starch–iodine complex becomes unstable and may give inaccurate results. Near the endpoint, only a small amount of iodine remains, making the colour change (blue → colourless) sharp and distinct.

(c) Iodine $Na_2S_2O_3.5H_2O$

$$\frac{M_1 V_1}{n_1} = \frac{M_2 V_2}{n_2}$$

$$M_2 = \frac{M_1 V_1}{n_1} \times \frac{n_2}{V_2}$$

$$M_1 = \frac{0.100 \times 10.0}{2} \times \frac{1}{20.0}$$

$$M_1 = 0.025\ M$$

(d) Mass of iodine per dm^3 = Molarity (M_1) × Molar mass of I_2

= 0.025 × 254

= 6.35 g dm^{-3}

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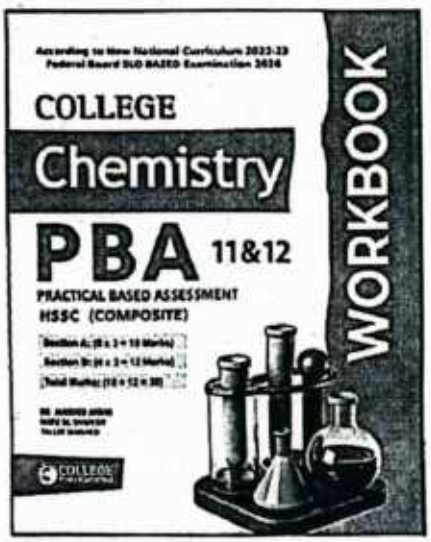
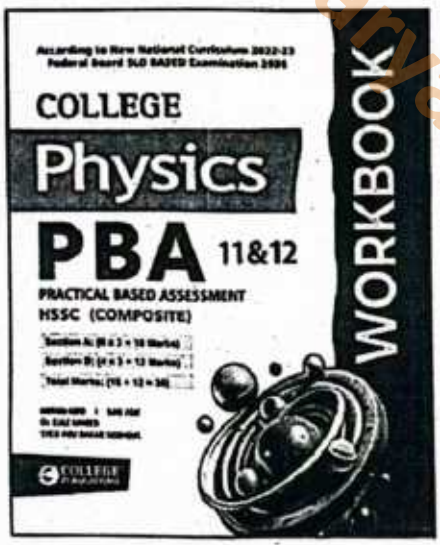
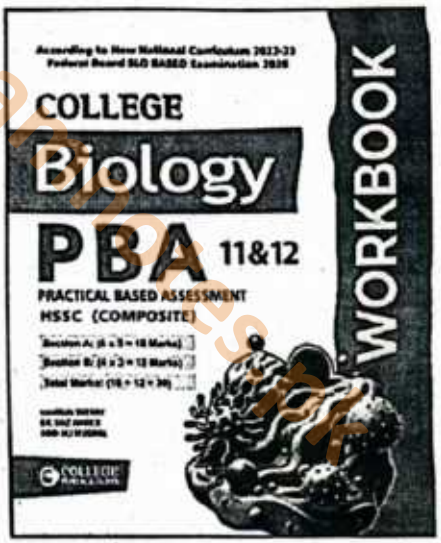
SECTION B

40% of Practical Marks

12 Marks (4 x 3 = 12)







01 EXPERIMENT

Prepare Iodoform by using ethanol. (Name of reagents, lab apparatus and chemical equation is required).

Principle:

Aldehydes, methyl ketones and primary, secondary alcohols having α-methyl groups react with I_2 to form yellow crystals of iodoform in the presence of a base.

Chemicals required: Ethyl alcohol = 20cm³ Sodium carbonate= 20g. Iodine crystals

Apparatus:

Iodine, round bottom flask, funnel, tripod stand, measuring cylinder, water bath, filter paper, wire guaze.

Chemical equation:

$$CH_3CH_2OH + 4I_2 + 3Na_2CO_3 \rightarrow CHI_3 + 5NaI + 3CO_2 + 2H_2O + HCOONa$$

Procedure:

- Take 100 cm³ of distilled water in a round bottom flask.
- Add 20g of Na_2CO_3 in it. For complete dissolution shake well.
- Heat this solution on water bath upto 60°C and add 20 cm³ of ethyl alcohol in it.
- Add few crystals of solid iodine in above solution and shake well until the disappearance of brown colour of iodine. Continue this process until the brown colour of iodine is no more discharged.
- At this stage yellow crystals of iodoform begins to separate out form the solution.
- Keep this solution for sometime to get the maximum crystals of iodoform.
- Separate these precipitates by filtration.
- Recrystallize iodofrom by dissolving in ether or alcohol.
- Dry the crystals between folds of filter paper.
- The melting point of iodoform is 119°C

Result: Pure and dry crystals are prepared and shown to the examiner.

VIVA VOCE

Q 1. Write IUPAC name of iodoform.
Ans Triiodomethane

Q 2. How iodoform crystals can be washed?
Ans These can be washed with cold water.

Q 3. What is the importance of this reaction?
Ans It is used to identify primary, secondary alcohols having α-methyl groups, methyl ketones and acetaldehyde.

Q 4. How can iodoform be purified?
Ans Iodoform is purified by recrystallization from alcohol or ether

Q 5. Can NaOH be used in place of Na_2CO_3 for preparing iodoform?
Ans Yes NaOH can be used.

Q 6. What is the physical state and odor of iodoform?
Ans Iodoform is a yellow crystalline solid with a characteristic antiseptic odor.

Q 7. The disappearance of brown colour of iodine is an indication that the reaction is proceeding?
Ans: The brown colour of iodine disappears when iodine reacts with alcohol under alkaline conditions, forming iodoform

Q 8. Can secondary alcohols give a positive iodoform test?
Ans: Only secondary alcohols with α-methyl group give iodoform test. This methyl group is attached to the carbon bearing the OH. Others do not react.

Q 9. What safety precautions should be taken while performing this experiment?
Ans: Handle iodine carefully as it is toxic and irritant. Use a water bath instead of direct flame. Wear gloves and goggles. Work in a well-ventilated area.

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PRACTICAL BASED ASSESSMENT (PBA) TEST-1 Marks 04

Q 1. (a) Name the base used in the preparation of iodoform from ethanol and mention the temperature used. [1+1]

(b) Write down the chemical equation for the preparation of iodoform from ethanol. [1]

(c) Identify the yellow precipitate formed in the reaction. [1]

PRACTICAL BASED ASSESSMENT (PBA) TEST-2 Marks 04

Q1 (a) Which functional group in ethanol reacts with iodine to form iodoform and which gas is released during the reaction of ethanol with iodine in the presence of sodium carbonate? [1+1]

(b) Write the balanced chemical equation for the reaction of ethanol with iodine in the presence of NaOH instead of Na_2CO_3. Also, compare the two bases in terms of the product formed. [1+1]

SOLUTION PRACTICAL BASED ASSESSMENT (PBA) TEST-1 Marks 04

Q1. (a) Base used is sodium carbonate (Na_2CO_3) and temperature used is about 60°C to accelerate reaction.

(b) $CH_3CH_2OH + 4I_2 + 3Na_2CO_3 \rightarrow CHI_3 + 5NaI + 3CO_2 + 2H_2O + HCOONa$

(c) Yellow precipitate: Iodoform (CHI_3)

SOLUTION PRACTICAL BASED ASSESSMENT (PBA) TEST-2 Marks 04

Q1. (a) $-CH_3$ group attached to the $-CH_2-OH$ (α-methyl group) reacts with iodine to give iodoform. Carbon dioxide (CO_2) gas is evolved.

(b) $CH_3CH_2OH + 4I_2 + 6NaOH \rightarrow CHI_3 + 5NaI + 5H_2O + HCOONa$
$CH_3CH_2OH + 4I_2 + 3Na_2CO_3 \rightarrow CHI_3 + 5NaI + 3CO_2 + 2H_2O + HCOONa$
Both NaOH and Na_2CO_3 give iodoform, but Na_2CO_3 releases CO_2 while NaOH does not.

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02 EXPERIMENT

Identify Aldehyde and Ketone functional Group by using Fehling solution and tollen's reagent.

Identification of Aldehyde

No.	EXPERIMENSTS	OBSERVATIONS	INFERENCES
1	**Litmus Test.** Aq. solution + blue litmus solution	No change	Acidic compound absent.
2	**$NaHCO_3$ Test.** Organic compound + 5% $NaHCO_3$ solution	Insoluble	Carboxylic acid is absent.
3	**NaOH Test.** Organic compound + 5% NaOH. solution.	No reaction occurred.	Phenols are absent.
4	**2,4-Dinitrophenyl hydrazine test** Organic compound + 2,4-DNPH	Yellow ppt. formed	Aldehyde or ketone is present.
5	**Silver mirror test** $AgNO_3$ solution + 2-3 drops NH_4OH + Organic compound + warm on a water bath	Silver mirror formed on the walls of the test tube.	Aldehyde is confirmed.
6	**Fehling's solution test.** Organic compound + Fehling's solution + heat	Brick red ppt. of Cu_2O formed	Aldehyde is confirmed.
7	**Benedict test** Organic compound + Benedict solution + Heat	Brick red ppt. of Cu_2O formed	Aldehyde is confirmed.

Identification of Ketone

No.	EXPERIMENSTS	OBSERVATIONS	INFERENCES
1	**Litmus Test.** Aq. solution + blue litmus solution	No change	Acidic compound absent.
2	**$NaHCO_3$ Test.** Organic compound + 5% $NaHCO_3$ solution	Insoluble	Carboxylic acid or nitrophenols are absent.
3	**NaOH Test.** Organic compound + 5% NaOH solution.	No reaction occurred.	Phenols are absent.
4	**2,4-Dinitrophenyl hydrazine test** Organic compound + 2,4-DNPH	Yellow ppt. formed	Aldehyde or ketone is present.
5	**Silver mirror test** $AgNO_3$ solution + 2-3 drops NH_4OH + Organic compound + warm on a water bath	No silver mirror formed	Aldehyde is absent.
6	**Fehling's solution test.** Organic compound + Fehling's solution + heat	No brick red ppt.	Aldehyde is absent.
7	***Sodium nitroprusside solution*** Organic compound + sodium nitroprusside solution	Wine red colour appears	Ketone is confirmed.

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VIVA VOCE

Q. 1 What is an organic compound?

Ans Compounds of C and H and their derivatives are called organic compounds.

Q. 2 Define functional group.

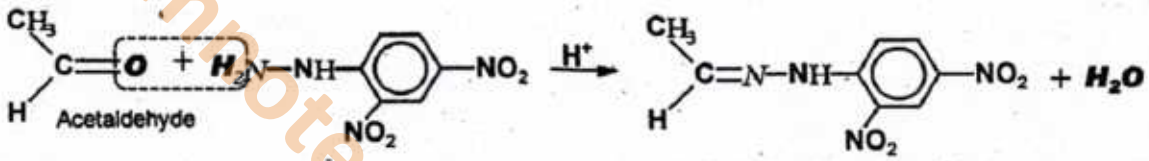
Ans An atom or a group of atoms which imparts special characteristics to the compound.

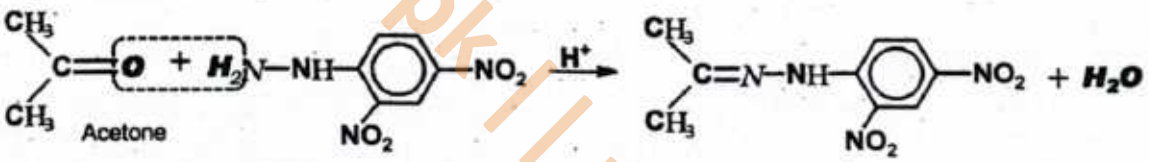
Q. 3 Which test is called a silver mirror test?

Ans Tollen's test is called silver mirror test because in it metallic silver is deposited in the test tube.

Q. 4 Give a test which indicate the presence of group in a carbonyl compound?

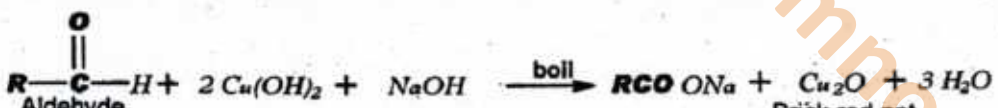
Ans Aldehydes and ketones react with 2,4-dinitrophenylhydrazine to form 2,4-dinitrophenylhydrazone in the presence of an acid. The 2,4-dinitrophenylhydrazones are usually yellow or orange crystalline solids





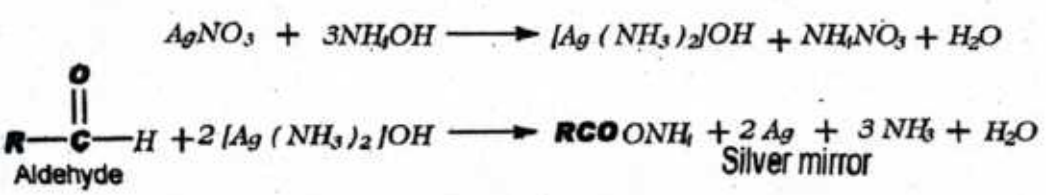
Q. 5 What is Fehling's solution test?

Ans Aldehyde is oxidized to salt of carboxylic acid and Cu^{2+} is reduced to Cu^{+}. So, Brick red ppt. of Cu_2O are formed. Ketones do not give this test.



Q. 6 What is Tollen's test (Silver mirror test)?

Ans Tollens reagent is ammoniacal silver nitrate with the chemical formula $[Ag(NH_3)_2]NO_3$. When aldehyde is warmed with Tollen's reagent a silver mirror is formed on the inside of the test tube. This test is also known as silver mirror test. This test is given by aldehyde. Ketones do not give this test



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Q. 7 What is Sodium nitroprusside test?

Ans Ketone responds to this test. Ketone reacts with alkali and forms an anion which further reacts with sodium nitroprusside and forms a coloured complex ion. Aldehydes do not respond to this test.

$$CH_3COCH_3 + OH^- \rightarrow CH_3COCH_2^- + H_2O$$
$$[Fe(CN)_5NO]^{2-} + CH_3COCH_2^- \rightarrow [Fe(CN)_5NO.CH_3COCH_2]^{3-}$$

Q. 8 Name any one test to distinguish aldehyde from ketone.

Ans Tollen's test is a qualitative laboratory test used to distinguish between an aldehyde and a ketone, also known as a silver-mirror test. It takes advantage of the fact that aldehydes are oxidized readily, while ketones are not.

Q. 9 What is Tollen's reagent?

Ans Tollens reagent is ammoniacal silver nitrate with the chemical formula $[Ag(NH_3)_2]NO_3$.

Q. 10 What is Fehling's solution?

Ans The solution of Fehling is prepared by combining two separate solutions, known as Fehling's A and Fehling's B. Fehling's A is aqueous solution of deep blue copper(II) sulphate. Fehling's B is a colourless solution of Potassium sodium tartrate (also known as Rochelle salt) made from strong alkali, commonly made from sodium hydroxide.

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PRACTICAL BASED ASSESSMENT (PBA) TEST-1 Marks 04

Q (a) A given organic compound X gives brick red ppt, with Fehling's solution and form silver mirror with Tollen's reagent. Identify the functional group in compound X. **[1]**

(b) Write the chemistry of Fehling solution test **[2]**

(c). Which reagent is used in silver mirror test? **[1]**

PRACTICAL BASED ASSESSMENT (PBA) TEST-2 Marks 04

Q. **(a)** A given organic compound Y gives orange ppt. with 2,4-dinitrophenylhydrozine and red colour with sodium nitroprusside. Identify the organic compound Y? **[1]**

(b) Write formula of 2,4-dinitrophenylhydrozine. Give its reaction with a ketone? **[1+1]**

(c) Write general formulas of aldehydes and ketone? **[1]**

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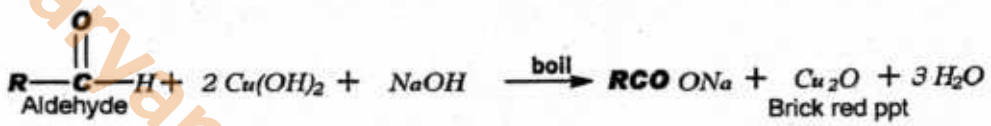
SOLUTION PRACTICAL BASED ASSESSMENT (PBA) TEST-1 Marks 04

Q. (a)

Aldehyde reacts with Fehling's solution to give red ppt. of Cu_2O. Ketones do not give this test.
Aldehyde reacts with Tollen's reagent and a silver mirror is formed on the inside of the test tube. This test is also known as silver mirror test. Ketones do not give this test.
Thus the given organic compound **X** is an aldehyde

(b)

Aldehydes and ketones can be distinguished by Fehling's solution test. Aldehyde is oxidized to salt of carboxylic acid and Cu^{2+} is reduced to Cu^{+}. So, Brick red ppt. of Cu_2O are formed. Ketones do not give this test.



(c)

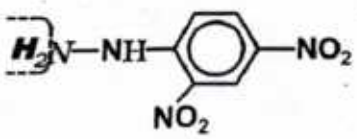
Tollen's reagent is used. It is an ammonical silver nitrate solution with the chemical formula $[Ag(NH_3)_2]NO_3$.

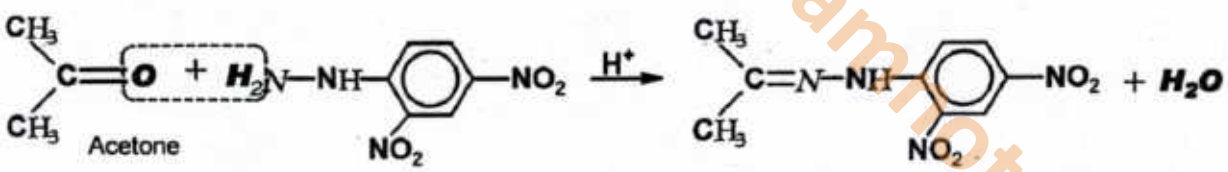
SOLUTION PRACTICAL BASED ASSESSMENT (PBA) TEST-2 Marks 04

Q.(a)

Both aldehydes and ketones react with 2,4-dinitrophenylhydrazine to form 2,4-dinitrophenylhydrazone which are usually yellow or orange crystalline solids. However, only ketones react with sodium nitroprusside to give red colour. Aldehydes do not give red colour with sodium nitroprusside. So, the given organic compound Y is a ketone.

(b)

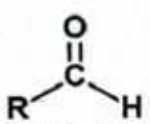




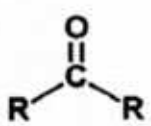
(2,4-Dinitrophenyl)hydrazine or 2,4-DNPH

Acetone (2,4-dinitrophenyl)hydrazone or acetone 2,4-DNPH

(c)



Aldehyde :



Ketone :

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03 EXPERIMENT

Perform an organic analysis test to identify the presence of compound such as alkene or alcohol by observing the change in colour of acidified $KMnO_4$ solution from purple to colourless, indicating oxidation.

Principle

Potassium permanganate ($KMnO_4$) is a strong oxidizing agent. Unsaturated compounds (alkenes) and some oxidisable alcohols react with $KMnO_4$ and reduce the purple permanganate ion (MnO_4^-) to a colourless or brown solution. A colour change from purple to colourless indicates oxidation and presence of an alkene or alcohol.

Chemical Equations

Alkene

Alkenes are oxidized to ethylene glycol by $KMnO_4$. The colour of $KMnO_4$ is discharged. This is called Baeyer's test.

$$3CH_2{=}CH_2 + 2KMnO_4 + 4H_2O \rightarrow \underset{\underset{OH}{|}}{\overset{\overset{OH}{|}}{3CH_2-CH_2}} + 2MnO_{2\,(s)} + 2KOH$$

(Ethylene glycol)

Alcohol

$KMnO_4$ oxidizes primary alcohols to aldehyde then finally to carboxyl acids.

$$3CH_3CH_2OH + 2KMnO_4 \rightarrow 3CH_3COOH + 2MnO_{2(s)} + 2KOH + H_2O$$

$KMnO_4$ oxidizes secondary alcohols to ketones.

$$3CH_3CHOHCH_3 + 2KMnO_4 \rightarrow 3CH_3COCH_3 + 2MnO_{2(s)} + 2KOH + H_2O$$

Aldehydes

Aldehydes are oxidized to carboxyl acids.

$$3CH_3CHO + 2KMnO_4 + H_2O \rightarrow 3CH_3COOH + 2MnO_{2(s)} + 2KOH$$

Apparatus

Test tubes, test tube rack, droppers, beakers, measuring cylinder, glass rod, watch glass, labelled sample vials, safety goggles, gloves.

Chemicals

Potassium permanganate solution, dilute sulfuric acid (for acidified $KMnO_4$), ethanol, water, and organic samples

Procedure

- Label test tubes for different samples.
- Add 1 cm^3 of the organic sample to each tube.
- Add 2 cm^3 of water or ethanol to help mix the sample.
- Add 1 cm^3 of dilute $KMnO_4$ to each test tube using a dropper.
- Gently shake or warm and observe the colour change for a few minutes.
- Repeat using different samples.

Observations and Results

Sample	Initial Colour	Final Colour	Inference
Alkene (e.g., ethene)	Purple	Brown	Alkene present; double bond oxidized
Aldehyde (e.g., ethanal)	Purple	Colourless/Brown	Aldehyde oxidized to carboxylic acid
Alcohol (primary)	Purple	Brown	Oxidizable primary alcohol present
Alcohol (secondary)	Purple	Brown	Oxidizable secondary alcohol present

Result

If the purple colour disappears or turns brown, the compound contains an alkene or oxidisable group. If there is no change, the compound is likely saturated or unreactive under these conditions.

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VIVA VOCE

Q 1. What is the role of potassium permanganate in this experiment?
Ans: It acts as a strong oxidizing agent to detect unsaturation or oxidizable groups in compounds.
Q 2. Why is $KMnO_4$ acidified in this test?
Ans: Acidification increases its oxidizing ability and ensures proper reaction with the organic sample.
Q 3. What indicates a positive Baeyer's test for alkenes?
Ans: The purple colour of $KMnO_4$ disappears or turns brown due to formation of MnO_2.
Q 4. What is formed when an alkene reacts with $KMnO_4$?
Ans: Ethylene glycol (a diol) and manganese dioxide (MnO_2) are formed.
Q 5. How are primary alcohols affected by $KMnO_4$?
Ans: They are oxidized first to aldehydes and then to carboxylic acids, causing decolorization of $KMnO_4$.
Q 6. What happens when a secondary alcohol reacts with $KMnO_4$?
Ans: It is oxidized to a ketone, and the purple $KMnO_4$ turns brown.
Q 7. How does $KMnO_4$ react with aldehydes?
Ans: Aldehydes are oxidized to carboxylic acids, decolorizing $KMnO_4$.
Q 8. Why might a sample show no colour change with $KMnO_4$?
Ans: The compound may be saturated or resistant to oxidation under these conditions. e.g. hexane, acetic acid.
Q 9. What is the significance of observing a brown precipitate in the test?
Ans: It indicates the formation of MnO_2, confirming oxidation of the sample.
Q 10. Why is it important to shake or gently warm the mixture during the test?
Ans: It ensures proper mixing and accelerates the oxidation reaction for clear observation.

PRACTICAL BASED ASSESSMENT (PBA) TEST-1 Marks 04

Q. **(a)** Name the reagent used to detect double bonds in organic compounds and mention its colour before reaction. **[1]**

(b) When an alkene reacts with this reagent, a new compound with two –OH groups is formed. Write the chemical equation for this reaction. **[2]**

(c) What is the solid brown residue that appears during this reaction? **[1]**

PRACTICAL BASED ASSESSMENT (PBA) TEST-2 Marks 04

Q. **(a)** List two types of organic functional groups that give a positive reaction with acidified $KMnO_4$. What visible change confirms the reaction? **[1+1]**

(b) Write the balanced chemical equation for the oxidation of a secondary alcohol using $KMnO_4$. How does the product differ when a primary alcohol is used instead? **[2]**

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PRACTICAL BASED ASSESSMENT (PBA) TEST-3 Marks 04

Q. **(a)** Explain why some compounds do not react with $KMnO_4$. Give one example. [1+1]

(b) A student tests ethanol and observes the purple colour disappears completely. Name the product formed and the solid deposited. [2]

SOLUTION PRACTICAL BASED ASSESSMENT (PBA) TEST-1 Marks 04

Q. **(a)** Acidified potassium permanganate ($KMnO_4$), purple in colour.

(b) $3CH_2{=}CH_2 + 2KMnO_4 + 4H_2O \rightarrow 3CH_2(OH){-}CH_2(OH) + 2MnO_{2\,(s)} + 2KOH$

(Ethylene glycol)

(c) Brown solid: Manganese dioxide (MnO_2)

SOLUTION PRACTICAL BASED ASSESSMENT (PBA) TEST-2 Marks 04

(a) Functional groups: Alkenes (C=C) and oxidizable alcohols (-OH). The visible change is that the purple $KMnO_4$ disappears or turns brown.

(b) Secondary alcohol: $3CH_3CHOHCH_3 + 2KMnO_4 \rightarrow 3CH_3COCH_3 + 2MnO_{2(s)} + 2KOH + H_2O$
Primary alcohols are finally oxidized to carboxylic acids while secondary alcohols are oxidized to ketones

SOLUTION PRACTICAL BASED ASSESSMENT (PBA) TEST-3 Marks 04

(a) Compounds without double bonds or oxidizable groups do not react, e.g., hexane, acetic acid.

(b) Ethanol is oxidized to acetic acid: $3CH_3CH_2OH + 2KMnO_4 \rightarrow 3CH_3COOH + 2MnO_{2(s)} + 2KOH + H_2O$
The solid formed is manganese dioxide (MnO_2)

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04 EXPERIMENT

Identify the Phenol Functional Group

Sr. No.	EXPERIMENSTS	OBSERVATIONS	INFERENCES
1	**Litmus Test.** Aq. solution + blue litmus solution	Blue litmus turned red	Acidic compound present. May be carboxylic acid or phenol
2	**$NaHCO_3$ Test.** Organic compound + 5% **$NaHCO_3$** solution.	No effervescence	Carboxylic acid is absent Phenol is present
3	**NaOH Test.** Organic compound + 5% NaOH. solution.	Organic compound is soluble	Phenol is present
4	**$FeCl_3$ Test** Organic compound + few drops of neutral $FeCl_3$	Blue or green or violet colouration	Phenol is confirmed.
5	**Bromine water test** Organic compound + Bromine water	Red colour of bromine water is discharged and white ppt. formed	Phenol is confirmed

VIVA VOCE

Q. 1 How phenols and carboxylic acids can be differentiad?

Ans (i). Neutral $FeCl_3$ test for an acid it produces red or yellow ppt., but for phenol it produces green blue or purple colour.

(ii). Caboxylic acids react with $NaHCO_3$ to give CO_2 which evolves with effervescence, while phenols does not give CO_2.

$$RCOOH + NaHCO_3 \rightarrow RCOONa + CO_2 + H_2O$$

Q. 2 How to distinguish phenol from aniline?

Ans Phenol is soluble in aqueous sodium hydroxide solution whereas aniline is not soluble. In other way aniline is soluble in dilute hydrochloric solution but phenol is not soluble.

Q. 3 What causes brisk effervescence in the sodium bicarbonate test?

Ans The evolution of carbon dioxide during the reaction causes brisk effervescence in sodium bicarbonate test.

Q. 4 What type of reaction takes place when phenol is treated with bromine solution?

Ans Aromatic electrophilic substitution reaction takes place when bromine is treated with phenol.

Q. 5 In the preparation of ferric chloride solution the brown precipitate formed is?

Ans The brown precipitate formed during the preparation of ferric chloride solution is ferric hydroxide.

Q. 6 How bromine water test is used to identify phenol?

Ans When phenol is treated with bromine water, the red colour of bromine is discharged and white ppt. are formed.

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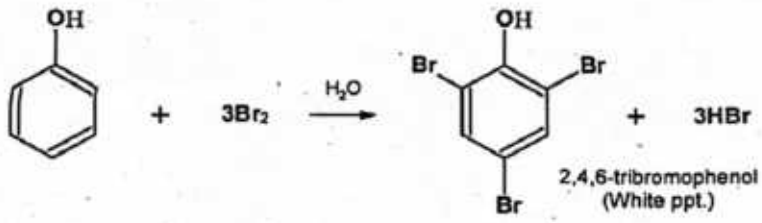


Q. 7 Why phenol gives violet colouration with netural $FeCl_3$?

Ans Aqueous solution of phenol reacts with freshly prepared neutral ferric chloride solution gives coloured complex. Thus, phenol gives violet colouration

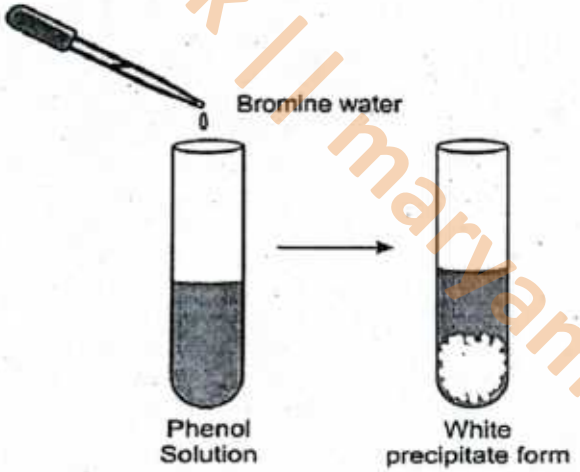
The chemical reaction is given below.

$$6C_6H_5OH + FeCl_3 \rightarrow [Fe(C_6H_5O)_6]^{3-} \text{ (violet colour complex)} + 3HCl + 3H^+$$

PRACTICAL BASED ASSESSMENT (PBA) TEST-1 Marks 04

Q **(a)** Sodium bicarbonate test cannot be used to identify phenol. Why? **[1]**

(b) Following is the chemical test carried out for phenol detection. Write complete reaction for the formation of white precipitates **[2]**



(c) How phenols can be differentiate from carboxylic acids? **[1]**

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PRACTICAL BASED ASSESSMENT (PBA) TEST-2 Marks 04

Q. (a) What happens when a phenol is treated with NaOH? **[1]**

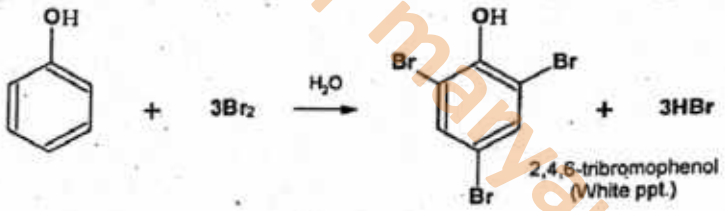
(b) A substance Z turns blue litmus red. It does evolve CO_2 when treated with $NaHCO_3$. The substance Z discharges red colour of bromine water. Identify the substance Z? Justify your answer **[2]**

(c) How phenols may be detected by neutral $FeCl_3$ test? Give reaction? **[1]**

SOLUTION PRACTICAL BASED ASSESSMENT (PBA) TEST-1 Marks 04

Q. (a) Phenol is a weak acid. It cannot decompose $NaHCO_3$ to give CO_2 gas. Thus, no effervescence is observed. Hence, Phenol cannot b identified by sodium bicarbonate test.

(b) When phenol is treated with bromine water, the red colour of bromine is discharged and white ppt. are formed.



(c) Caboxylic acids react with $NaHCO_3$ to give CO_2 which evolves with effervescence

$$RCOOH + NaHCO_3 \rightarrow RCOONa + CO_2 + H_2O$$

SOLUTION PRACTICAL BASED ASSESSMENT (PBA) TEST-2 Marks 04

Q. (a) Phenol is dissolve in aq. NaOH solution due to formation of sodium phenoxide

sodium phenoxide

(b) Since substance Z turns blue litmus red so it is an acid. It is either carboxylic acid or phenol. Since it does not evolve CO_2 from $NaHCO_3$, so it is not carboxylic acid. Since, it discharges colour of bromine water and forms white ppt., therefore, substance Z is a phenol.

(c) Aqueous solution of phenol reacts with freshly prepared neutral ferric chloride solution gives coloured complex. Thus, phenol gives violet colouration

$$6C_6H_5OH + FeCl_3 \rightarrow [Fe(C_6H_5O)_6]^{3-} \text{ (violet colour complex)} + 3HCl + 3H^+$$

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05 EXPERIMENT

Estimate the Amount of Ba^{2+} in the Given Solution of $BaCl_2$ Gravimetrically.

Principle:

Ba^{2+} ions present in given solution are converted into $BaCrO_4$ ppt. by adding excess K_2CrO_4 solution. The $BaCrO_4$ ppt. are filtered, dried and weighed.

Chemical required:

Ba^{2+} ions solution, conc. HCl. K_2CrO_4 solution.

Apparatus:

Beaker, Funnel, tripod stand. Burner wire gauze. Oven. Measuring cylinder. Filter paper etc.

Chemical Equation:

$$Ba^{2+} + K_2CrO_4 \rightarrow BaCrO_4 + 2K^+$$

Procedure:

- Take a beaker. Add 20cm^3 of Ba^{2+} ions solution in it.
- Add 1cm^3 of conc. HCl to the soultion and heat it to boiling.
- Now add K_2CrO_4 solution in excess in order to precipitate Ba^{2+} ions as $BaCrO_4$.
- Boil this for 2-3 minutes and allow the ppt. to settle down.
- Filter the solution through a pre-weighed filter paper to get ppt.
- Wash the ppt with hot water. Dry the ppt and weigh them.

Observations & Calculation

Mass of filter paper = 0.5 g
Mass of filter paper + ppt. = 1.0 g
Mass of $BaCrO_4$ ppt. = 1.0 – 0.5 = 0.50g
Formula mass of $BaCrO_4$ = 253.33 g / mol
Atomic mass of Ba^{2+} = 137.33 g / mol

Thus

253.33g $BaCrO_4$ contains Ba^{2+} ions = 137.33 g

0.50 g $BaCrO_4$ contains Ba^{2+} ions = $\frac{137.33 \times 0.50}{253.33} = 0.271g$

20 cm^3 of the given solution contains Ba^{+2} ions = 0.271 g

100 cm^3 of the given solution contains Ba^{+2} ions = $\frac{0.271 \times 100}{20} = 1.355g$

Result: The given solution contains 1.355 g of Ba^{2+} ions 100 cm^3 of solution.

VIVA VOCE

Q.1. Define gravimetric analysis?
Ans. The quantitative analysis which is based upon the weighing is called gravimetric analaysis.
Q.2. How precipitation of Ba^{2+} can be confirmed?
Ans. If by adding K_2CrO_4 solution no more ppt are formed then it indicates that precipitation is completed
Q.3. What are desiccating or drying agents? Name two desiccating agent?
Ans. The substances which can absorb moisture readily. $CaCl_2$ and P_2O_5 are two desiccating agents.
Q.5. What is digestion of ppt?
Ans. It is a phenomenon in which ppt are allowed to remain intact with hot liquid for few minutes
Q.6. How many types of filter media are sued in gravimetric analysis?
Ans Two types of filter media are used. a. filter paper b. sintered glass crucible

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PRACTICAL BASED ASSESSMENT (PBA) TEST-1 Marks 04

Q. **(a)** What reagent is added to the $BaCl_2$ solution to precipitate Ba^{2+} ions? Write the colour of the precipitate formed. **[1]**

(b) Give the balanced chemical equation for the precipitation of Ba^{2+} ions. **[1]**

(c) Why is concentrated HCl added before precipitation? Explain its purpose briefly. **[2]**

PRACTICAL BASED ASSESSMENT (PBA) TEST-2 Marks 04

Q. **(a)** Why must potassium chromate be added in excess during the estimation? **[1]**

(b) What precautions should be taken while filtering and washing the $BaCrO_4$ precipitate to ensure accurate results? **[1+1]**

(c) **If 0.50 g of $BaCrO_2$ is obtained, calculate the amount of Ba^{2+} present in it.**
(Atomic mass of Ba = 137.33 g/mol; Molar mass of $BaCrO_4$ = 253.33 g/mol). **[1]**

SOLUTION PRACTICAL BASED ASSESSMENT (PBA) TEST-1 Marks 04

Q. **(a)** Reagent: Potassium chromate (K_2CrO_4); yellow precipitate of barium chromate ($BaCrO_4$) forms.

(b) $Ba^{2+} + K_2CrO_4 \rightarrow BaCrO_4 + 2K^+$

(c) Concentrated HCl prevents the formation of basic salts. So, it ensures complete precipitation of pure $BaCrO_4$ by maintaining suitable acidity.

SOLUTION PRACTICAL BASED ASSESSMENT (PBA) TEST-2 Marks 04

Q. **(a)** Excess K_2CrO_4 ensures complete precipitation of all Ba^{2+} ions from solution.

(b) (i) The precipitate must be washed thoroughly with hot water to remove soluble impurities
(ii) The precipitates should be filtered carefully to avoid loss.

(c) Mass of Ba^{2+} = Mass of $BaCrO_4 \times 137.33 / 253.33$
$= 0.50\,g \times 137.33 / 253.33 =$ **0.271 g**

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06 EXPERIMENT

Investigating the rate of reaction by measuring the volume of gas produced.

Principle

The rate of a chemical reaction is the change in concentration of reactants or products per unit time. The rate can be determined by measuring the volume of gas evolved in a reaction at regular time intervals. When hydrochloric acid reacts with zinc, hydrogen gas is produced. By measuring the volume of H_2 evolved at different times, the rate of reaction can be investigated.

Chemical Equation: $Zn_{(s)} + 2HCl_{(aq)} \rightarrow ZnCl_{2(aq)} + H_{2(g)}$

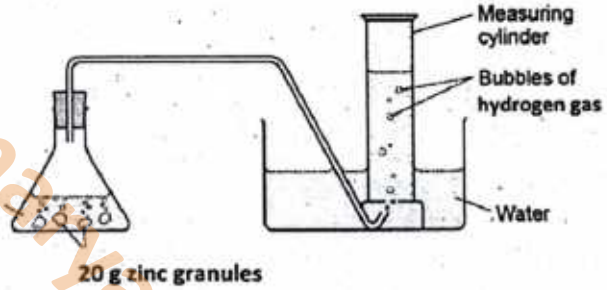
Apparatus

Conical flask, measuring cylinder with trough, stopwatch, delivery tube, beehive shelf, balance, thermometer, funnel.

Chemicals: Hydrochloric acid solutions (0.5 M, 1.0 M, 1.5 M), zinc granules, distilled water

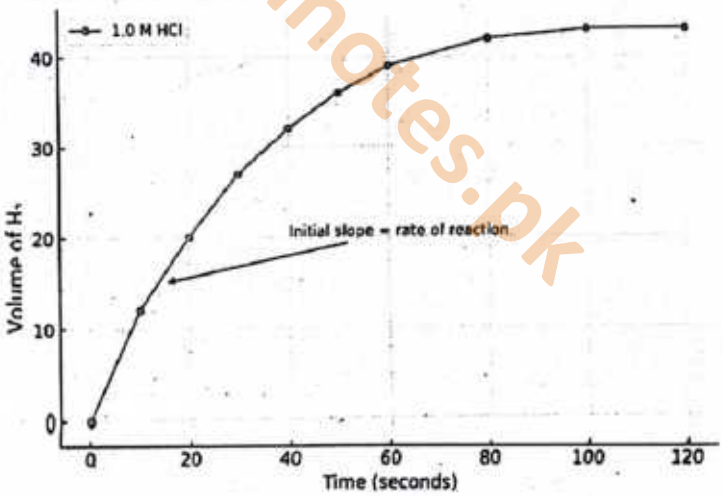
Procedure

- The apparatus was set up with an inverted measuring cylinder to collect H_2 gas.
- 25 cm^3 of hydrochloric acid of known molarity was measured and poured into a conical flask.
- About 20.0 g of zinc granules of uniform size was weighed and kept ready.
- The initial temperature of the acid was recorded.
- The zinc granules were quickly added to the acid, the flask was closed with the rubber bung, and the stopwatch was started.
- The volume of H_2 gas produced was recorded every 10 seconds until no further gas was evolved.
- The experiment was repeated using acids of different concentrations (0.5 M, 1.0 M, 1.5 M).
- A graph of volume of H_2 (cm^3) vs time (s) was plotted for each concentration.
- The initial slope of each graph was taken as the measure of the reaction rate.



Observations and Calculations

Time (s)	Volume of H_2 (cm^3)
0	0
10	12
20	20
30	27
40	32
50	36
60	39
80	42
100	43
120	43



- From the graph of Volume of H_2 vs time, the initial rate is determined from the slope at time = 0 by the formula.

  Initial rate = $\Delta V / \Delta t$

- Rates for different concentrations of HCl:

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Concentration of HCl (M)	Initial Rate (cm³/s)
0.5	0.6
1.0	1.2
1.5	1.8

Result

The rate of reaction between hydrochloric acid and zinc granules increases with increase in the concentration of HCl. This is because higher acid concentration provides more H^+ ions, leading to more frequent collisions between reacting particles.

VIVA VOCE

Q 1. What is the aim of this experiment?
To study how the rate of reaction between hydrochloric acid and calcium carbonate depends on the concentration of the acid.

Q 2. What gas is produced in the reaction between HCl and Zinc?
Hydrogen (H_2) gas is evolved.

Q 3. Write the balanced chemical equation for the reaction.
$Zn_{(s)} + 2HCl_{(aq)} \rightarrow ZnCl_{2(aq)} + H_{2(g)}$

Q 4. How is the rate of reaction determined in this experiment?
By measuring the volume of H_2 gas produced at regular time intervals.

Q 5. Why CO_2 gas collected over water cannot be used to investigate reaction rate?
The CO_2 gas is soluble in water to some extent. Thus, the amount of CO_2 gas evolved cannot be measured accurately.

Q 6. What happens to the rate of reaction when the concentration of HCl is increased?
The rate increases because higher concentration provides more H^+ ions, leading to more frequent collisions.

Q 7. Why is the same mass and size of zinc granules is used in all trials?
To keep the surface area constant so that only the concentration of acid affects the rate.

Q 8. What does the initial slope of the volume of H_2 gas vs time graph represent?
It represents the initial rate of reaction.

PRACTICAL BASED ASSESSMENT (PBA) TEST-1 Marks 04

Q. (a) Name the gas produced when hydrochloric acid reacts with zinc. Write its chemical formula. [1]

(b) Write the balanced chemical equation for the reaction between HCl and zinc. [1]

(c) Explain why the rate of reaction increases when the concentration of HCl is increased. [1]

(d) What type of graph is obtained when volume of H_2 (cm^3) is plotted against time (s), and what does its initial slope represent? [1]

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PRACTICAL BASED ASSESSMENT (PBA) TEST-2 Marks 04

Q. (a) Draw a labllled diagram for the apparatus setup for the production of hydrogen gas from zinc and HCl. **[1]**

(b) Define the term *rate of reaction* and write the formula used to calculate the initial rate from experimental data. **[1+1]**

(c) From the data below, calculate the average rate between 0 and 20 seconds: **[1]**
Time = 0 s, Volume = 0 cm^3 Time = 20 s, Volume = 20 cm^3

SOLUTION PRACTICAL BASED ASSESSMENT (PBA) TEST-1 Marks 04

Q. (a) Gas produced: hydrogen gas, H_2.

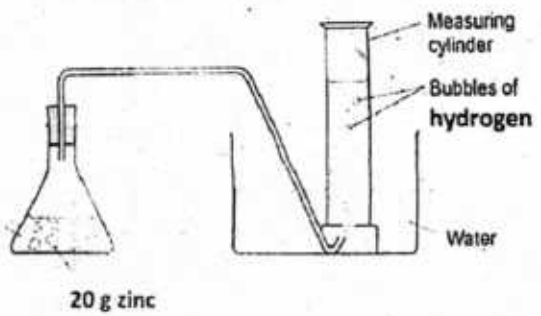
(b) Balanced equation: $Zn_{(s)} + 2HCl_{(aq)} \rightarrow ZnCl_{2(aq)} + H_{2(g)}$

(c) Increasing the acid concentration increases the number of H^+ ions per unit volume, leading to more frequent effective collisions and hence a faster rate of reaction.

(d) The graph is a curve that levels off with time; the initial slope represents the initial rate of reaction.

SOLUTION PRACTICAL BASED ASSESSMENT (PBA) TEST-2 Marks 04

Q2. (a)



(b) Rate of reaction is the change in concentration (or volume) per unit time
The rate of reaction is determine by the formula:
Rate = $\Delta V / \Delta t$

(c) The rate between 0–20 s:

$\Delta V = 20\ cm^3 - 0\ cm^3 = 20\ cm^3$

$\Delta t = 20\ s - 0\ s = 20\ s$

Thus, Rate $= \Delta V / \Delta t = 20\ cm^3 / 20\ s = 1.0\ cm^3/s$

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SECTION B 40% : Marks 12

PRACTICAL BASED ASSESSMENT (PBA) TESTS WITH SOLUTIONS:

PRACTICAL BASED ASSESSMENT (PBA) TEST-1 Marks 12

Q1. (a) Name the reagent used to test for the presence of aldehyde and write the observation. [1+1]

(b) State the colour change when an alkene reacts with acidified $KMnO_4$. [1]

(c) What is the principle of the iodoform test? [1]

Q2. (a) Which reagent is added to precipitate Ba^{2+} ions from $BaCl_2$ solution and what is the colour of the precipitate? [1+1]

(b) Write the balanced chemical equation for the reaction between $CaCO_3$ and HCl that may be used in the rate experiment. [1]

(c) What happens when an aldehyde reacts with ammoniacal silver nitrate on warming? [1]

Q3. (a) What colour change is observed when phenol reacts with neutral $FeCl_3$ solution? Write the inference. [1]

(b) Why does the purple colour of acidified $KMnO_4$ disappear when ethanol is added? What is the change in oxidation state of Mn? [1+1]

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(c) Calculate the amount of Ba^{2+} present in 0.50 g of $BaCrO_4$. [1]
(Atomic mass of Ba = 137.33 g/mol; Molar mass of BaCrO[] = 253.33 g/mol)

PRACTICAL BASED ASSESSMENT (PBA) TEST-2 Marks 12

Q1. **(a)** Write the chemical equation for the preparation of iodoform from ethanol. [1]

(b) What is the appearance and inference of the yellow precipitate formed in this test? [1+1]

(c) Give one reason why Na_2CO_3 solution is used in the iodoform preparation. [1]

Q2. **(a)** How hydrogen gas is collected during reaction of Zn and HCl for rate determination? [1]

(b) Write the equation showing oxidation of ethene by $KMnO_4$ and state the observation. [1+1]

(c) What is indicated when the purple colour of acidified $KMnO_4$ remains unchanged? [1]

Q3. **(a)** Which test is used to confirm phenol and what is the colour change? [1]

(b) Give one observation from Fehling's solution test for aldehyde and explain the inference. [1]

(c) State the principle of gravimetric estimation of Ba^{2+} ions. [2]

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SOLUTION PRACTICAL BASED ASSESSMENT (PBA) TEST-1 Marks 12

Q1.(a) *Reagent:* Fehling's solution.
Observation: Formation brick red ppt. of Cu_2O confirms aldehyde.

(b) *Colour change:* Purple to colourless/Brown. This indicates oxidation of alkene. This is called Baeyer's test.

(c) *Principle:* Alcohols or carbonyl compounds with α-methyl group react with iodine in base to form yellow crystals of iodoform (CHI_3).

Q2. (a) *Reagent:* Potassium chromate (K_2CrO_4).
Colour: Yellow precipitate of $BaCrO_4$.

(b) *Equation:* $CaCO_3 + 2HCl \rightarrow CaCl_2 + H_2O + CO_2\uparrow$

(c) *Observation:* Silver mirror forms; aldehyde is oxidized to acid.

$$AgNO_3 + 3NH_4OH \longrightarrow [Ag(NH_3)_2]OH + NH_4NO_3 + H_2O$$

$$R-\underset{\text{Aldehyde}}{\overset{O}{\overset{\|}{C}}}-H + 2[Ag(NH_3)_2]OH \longrightarrow RCOONH_4 + 2Ag + 3NH_3 + H_2O$$
(Silver mirror)

Q3.

(a) *Observation:* Blue, violet, or green colour.
Inference: Confirms phenolic –OH group.

(b) Ethanol is oxidized by $KMnO_4$ to acetic acid.
The Manganese (Mn) is reduced from Mn^{7+} in $KMnO_4$ to Mn^{4+} in MnO_2. Hence purple colour disappears.

(c) Mass of Ba^{2+} = Mass of $BaCrO_4 \times 137.33 / 253.33$
$= 0.50\,g \times 137.33 / 253.33 = 0.271\,g$

SOLUTION PRACTICAL BASED ASSESSMENT (PBA) TEST-2 Marks 12

Q1.

(a) $CH_3CH_2OH + 4I_2 + 3Na_2CO_3 \rightarrow CHI_3 + 5NaI + 3CO_2 + 2H_2O + HCOONa$

(b) Yellow crystals of iodoform appear. This confirms presence of ethanol or methyl ketone.

(c) Na_2CO_3 provides alkaline medium needed for oxidation and halogen substitution.

Q2.(a) H_2 gas is insoluble in water. So, it is collected by downward displacement of water in a measuring cylinder.

(b)

$$3CH_2=CH_2 + 2KMnO_4 + 4H_2O \rightarrow \underset{\text{(Ethylene glycol)}}{3CH_2(OH)-CH_2(OH)} + 2MnO_{2\,(s)} + 2KOH$$

The purple colour of $KMnO_4$ discharge to light brown colour. This confirms the presence of unsaturation.

(c) No reaction; the compound is saturated or non-oxidizable.

Q3.(a) *Test:* Neutral $FeCl_3$ test is used to confirm phenol. *Colour change:* Blue, violet, or green indicates phenol.

(b) *Observation:* Brick-red ppt. of Cu_2O are formed with Fehling's solution. This confirms aldehyde.

(c) *Principle:* Ba^{2+} ions are precipitated as $BaCrO_4$, These are filtered, dried, and weighed. From the mass of $BaCrO_4$, the amount of Ba^{2+} content is calculated stoichiometrically.

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FBISE (PBA) MODEL PAPER Marks 30

Model Question Paper Chemistry HSSC (COMPOSITE) For Annual Examination 2026 & onwards Practical Based Assessment (PBA) Chemistry Curriculum (2022-23)-Scheme of Studies 2006

Total Marks: 30 **Time: 2 Hour 30 minutes**

Note: Attempt all questions and write answers within provided spaces on E-Sheet.

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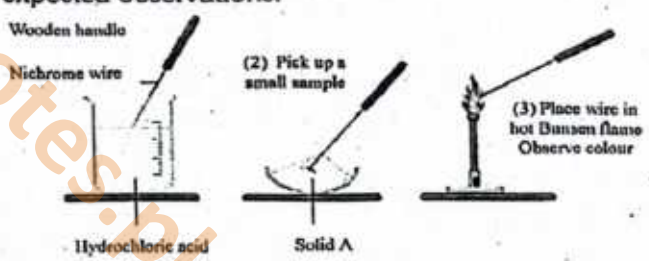
SECTION A (6 × 3 = 18)

Q No.1. Two solids A and solid B, were analyzed. A was Barium chloride. Tests were done on A and B.

(a) Tests on A: Complete the expected observations.



(i) A Student performs a flame test 'A'. What is the flame colour observed? **[1]**

Specific amount of A was added to distilled water to prepare its solution in a test-tube. Divide A into two equal portions in two test-tubes.

(ii) To the first portion of solution A, add aqueous silver nitrate followed by a few drops of dilute solution of aqueous ammonia. Write its observation. **[1]**

(iii) To the second portion of solution A, add dilute sulfuric acid. Write its observation. **[1]**

(b) Tests on B

Specific amount of B was added to distilled water to prepare its solution in a test-tube. Students' divide this solution into two portions.

Following table shows the tests and the student's observations for compound B.

Tests	Observations
Test 1 : Appearance of B	light green colour
Test 2 : An excess of aqueous sodium hydroxide was added to the first portion of solution B.	Green ppts are formed which remain insoluble in excess of sodium hydroxide.
Test 3 : Dilute nitric acid and aqueous barium nitrate were added to the second portion of solution B.	White ppts are formed.

(i) Name the cation present in solution B. [1]

(ii) Write down formula of the precipitates formed in test 2. [1]

(iii) Write the name of B. [1]

Q No.2. The formula for iron (II) sulphate crystals is $FeSO_4.xH_2O$, where x is a whole number.
A student determined the value of 'x' using 0.0200 M Potassium manganate (VII). This was solution A. 28g of a given sample of $FeSO_4.xH_2O$ is dissolved per dm^3 of solution. This was solution B.

(a) A 25.0 cm^3 sample of solution B followed by half test tube of sulfuric acid was measured into the titration flask. Solution A was run from a burette into the flask containing Solution B until an endpoint was reached. What was the colour change at the end point? [1]

(b) Three titrations were done. The diagrams below show parts of the burette before and after each titration

Use these diagrams to complete the table of results.

Titration number	1	2	3
Final reading (cm^3)			
First reading (cm^3)			
Volume of solution A used			
Best titration result (✓)			

SUMMARY.

Tick (✓) the best titration results. Using these results, the average volume of A ---------- cm^3.

When acidified $KMnO_4$ reacts with hydrated Iron (II) sulfate, $FeSO_4.xH_2O$ the following reaction occurs:

$$2KMnO_4 + 10FeSO_4.xH_2O + 8H_2SO_4 \rightarrow K_2SO_4 + 2MnSO_4 + 5Fe_2(SO_4)_3 + (10x+8)H_2O$$

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(c) Calculate molarity of hydrated iron (II) sulfate by using the chemical equation and above data. **[2]**

(d) By using your answer to (c) and the strength of hydrated Iron (II) sulfate, calculate the value of 'x' (water of crystallization) in $FeSO_4.xH_2O$.

Q No.3. A 25 cm^3 solution of iodine was titrated with 0.1 mol dm^{-3} (molarity) solution of sodium thiosulfate. The titration required 15.5 cm^3 of sodium thiosulfate solution to reach the end point.

(a) Write balanced equation for the reaction between iodine and sodium thiosulfate. **[1]**

(b) Name the indicator used in this titration. Describe the change in colour that occurs when the end point of the titration is reached. **[2]**

(c) Calculate the moles of sodium thiosulfate used in the titration. **[1]**

(d) Use your answer to (c), calculate the concentration (molarity) of iodine in $moldm^{-3}$. **[2]**

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SECTION B (4 × 3 = 12)

Note: Attempt all questions and write answers within provided spaces.

Q No.4 **(a)** Write down the chemicals required for the preparation of iodoform. Also write the chemical equation involved. **[1+1]**

(b) Write the observation for identification of phenol. Also write down the chemical equation involved. **[1+1]**

Q No. 5 **(a)** Explain how to identify the presence of aldehyde in a mixture of aldehyde and ketone. Provide chemical equation for the reaction involved. **[1+1]**

(b) Describe the set up required to measure the rate of reaction by collecting the volume of gas produced. Draw a diagram and label the apparatus used. **[1+1]**

Q No.6. A student performed an experiment to test for the presence of an organic compound that can be oxidised using acidified potassium manganate (VII) $KMnO_4$.

(a) What colour change in $KMnO_4$ shows that a compound can be oxidized? **[1]**

(b) Name one organic compound that can be detected using this test. **[1]**

(c) How does the oxidation state of Manganese change in acidified Potassium manganate (VII) during this reaction? **[2]**

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SOLUTION FBISE (PBA) MODEL PAPER Marks 30

SECTION A

Q No.1.

(a) Tests on A

(i) Apple-green flame is observed.

(ii) A white precipitate of silver chloride forms, which dissolves in dilute ammonia.

$BaCl_2(aq) + 2\,AgNO_3(aq) \rightarrow 2\,AgCl(s) + Ba(NO_3)_2(aq)$.

$AgCl(s) + 2\,NH_3(aq) \rightarrow [Ag(NH_3)_2]Cl(aq)$.

(iii) A white, insoluble precipitate of barium sulfate forms.

$BaCl_2(aq) + H_2SO_4(aq) \rightarrow BaSO_4(s) + 2HCl(aq)$.

(b) Tests on B

(i) Iron(II) ion (Fe^{2+})

(ii) $Fe(OH)_2$.

$FeSO_4(aq) + 2\,NaOH(aq) \rightarrow Fe(OH)_2(s) + Na_2SO_4(aq)$.

(iii) Iron(II) sulfate, $FeSO_4$.

Q No.2. **(a)** At the endpoint, the colour changes from Purple to very light pink or just colourless

(b)

Titration number	1	2	3
Final reading (cm^3)	25.9	48.6	32.4
First reading (cm^3)	0.0	23.3	6.9
Volume of solution A used	25.9	25.3	25.5
Best titration result (✓)		✓	✓

The average volume of A $= \dfrac{25.3 \times 25.5}{2} = 25.4\ cm^3$

(c) $\mathbf{FeSO_4.7H_2O}$ $\mathbf{KMnO_4}$

$$\frac{M_1 V_1}{n_1} = \frac{M_2 V_2}{n_2}$$

$$M_1 = \frac{M_2 V_2}{n_2} \times \frac{n_1}{V_1}$$

$$M_1 = \frac{0.0200 \times 25.4}{2} \times \frac{10}{25.0}$$

$$M_1 = 0.102\ M$$

(d) Given mass of $FeSO_4.xH_2O$ dissolved per dm^3 $= 28$ g

Molar mass of $FeSO_4.xH_2O$ $= 56+32+16 \times 4 + 18x$

$= 152 + 18x$

Mass of $FeSO_4.xH_2O$ per dm^3 = Molarity (M_2) × Molar mass of $FeSO_4.xH_2O$

$28 = 0.102 \times (152 + 18x)$

$$152 + 18x = \frac{28}{0.102}$$

$152 + 18x = 275$

$18x = 275 - 152$

$18x = 123$

$$x = \frac{123}{18} = 6.83 \approx \mathbf{7}$$

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Q No.3.

(a) $2Na_2S_2O_3.5H_2O + I_2 \rightarrow Na_2S_4O_6 + 2NaI + 10H_2O$

(b) 1% freshly prepared starch solution is used as indicator.
At the start, brown or yellow-brown colour appears due to liberation of iodine present. When the colour changes to lemon yellow during titration then starch is added and the deep blue appears. At the end-point blue disappears to colourless.

(c) Volume of $Na_2S_2O_3$ solution $= 15.5\ cm^3 = 15.5 / 1000 = 0.0155\ dm^3$
Molarity of $Na_2S_2O_3$ solution $= 0.1\ mol\ dm^{-3}$
Moles = Molarity × Volume
$= 0.1 \times 0.0155 =$ **0.00155 mol**

(d)

From the equation:

$2\ mol\ Na_2S_2O_3 = 1\ mol\ I_2$

$0.00155\ mol\ Na_2S_2O_3 = \frac{1}{2} \times 0.00155$

$= 0.000775\ mol$

Volume of I_2 solution $= 25\ cm^3 = 25 / 1000 = 0.025\ dm^3$
Moles of $I_2 = 0.000775\ mol$

$$\text{Molarity of } I_2 = \frac{\text{moles}}{\text{volume}} = \frac{0.000775}{0.025} = 0.031\ M$$

Or molarity can be calculated as

Iodine **$Na_2S_2O_3.5H_2O$**

$$\frac{M_1 V_1}{n_1} = \frac{M_2 V_2}{n_2}$$

$$M_2 = \frac{M_1 V_1}{n_1} \times \frac{n_2}{V_2}$$

$$M_1 = \frac{0.1 \times 15.5}{2} \times \frac{1}{25}$$

$$M_1 = 0.031\ M$$

SECTION B (4 x 3 = 12)

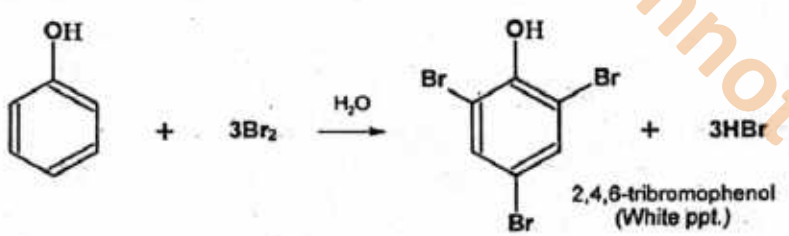
Note: Attempt all questions and write answers within provided spaces.

Q No.4

(a) Ethyl alcohol = $20cm^3$ Sodium carbonate = 20g. Iodine crystals

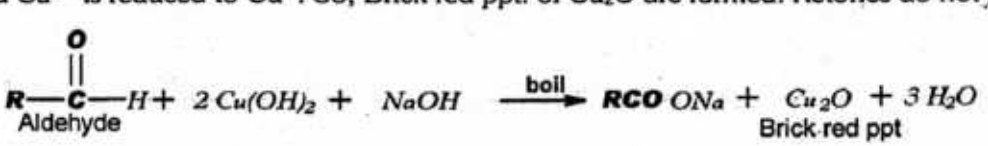
$CH_3CH_2OH + 4I_2 + 3Na_2CO_3 \rightarrow CHI_3 + 5NaI + 3CO_2 + 2H_2O + HCOONa$

(b) When phenol is treated with bromine water, the red colour of bromine is discharged and white ppt. are formed.



Q No. 5

(a) Aldehydes and ketones can be distinguished by Fehling's solution test. Aldehyde is oxidized to salt of carboxylic acid and Cu^{2+} is reduced to Cu^+. So, Brick red ppt. of Cu_2O are formed. Ketones do not give this test.



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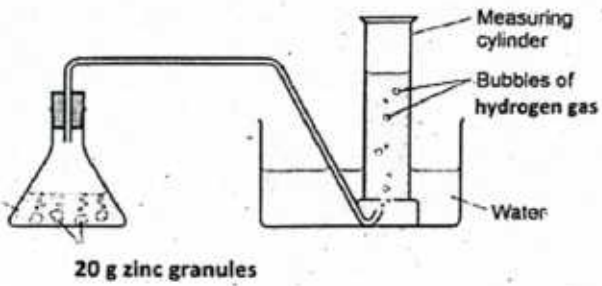
(b)

Procedure

- The apparatus was set up with an inverted measuring cylinder to collect H_2 gas.
- 25 cm^3 of hydrochloric acid of known molarity was measured and poured into a conical flask.
- About 20.0 g of zinc granules of uniform size was weighed and kept ready.
- The initial temperature of the acid was recorded.
- The zinc granules were quickly added to the acid, the flask was closed with the rubber bung, and the stopwatch was started.
- The volume of H_2 gas produced was recorded every 10 seconds until no further gas was evolved.



Q No.6.

(a) The purple colour of $KMnO_4$ disappears or turns brown due to formation of MnO_2. This indicates that compound has been oxidized.

(b) Ethene, ethyl alcohol, acetaldehyde

(c) Unsaturated compounds e.g. alkenes and some ox disable alcohols react with $KMnO_4$ and reduce it to MnO_2. The purple of $KMnO_4$ is discharged to a colourless or brown solution.
In $KMnO_4$, the oxidation state of Mn is +7, which reduces to +4 in MnO_2

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PRACTICE (PBA) MODEL PAPER-1 Marks 30

Model Question Paper Chemistry HSSC (COMPOSITE) For Annual Examination 2026 & onwards Practical Based Assessment (PBA) Chemistry Curriculum (2022-23)-Scheme of Studies 2006

Total Marks: 30 **Time: 2 Hour 30 minutes**

Note: Attempt all questions and write answers within provided spaces on E-Sheet.

SECTION A (6 × 3 = 18)

Q No. 1. Solid A was a soluble white salt, while B was a coloured crystalline solid. Experiments were performed to identify each compound.

(a) Tests on A

(i) A small sample of solid A was heated with copper turnings and concentrated sulfuric acid in a test tube. A reddish-brown gas was evolved that turned moist blue litmus paper red and then bleached it. Identify the anion present in A and write the name of the gas evolved. **[1]**

(ii) A portion of the aqueous solution of A was treated with iron(II) sulfate solution, followed by carefully adding concentrated sulfuric acid along the side of the test tube. A brown ring appeared at the junction of the two layers. What does this confirm? **[1]**

(iii) Write the balanced chemical equation for the brown ring test. **[1]**

(b) Tests on B

A compound B contains sulphate radical. A specific amount of compound B was dissolved in distilled water to prepare its aqueous solution in a clean test tube.
Students divided this solution into two portions and performed the following tests:

Tests	Observations
Test 1: Appearance of B	Blue crystalline solid
Test 2: An excess of aqueous ammonia was added to the first portion of solution B.	Light blue precipitate formed, which dissolved in excess to give a deep blue solution.
Test 3: To the second portion, potassium ferrocyanide solution was added.	A reddish-brown precipitate was produced.

(i) Name the cation present in solution B. **[1]**

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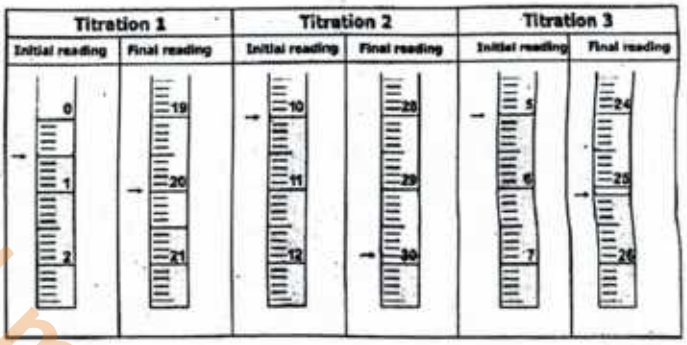
(ii) Write the formula of the precipitate formed in Test 2. **[1]**

(iii) Write the name of compound B. **[1]**

Q No.2. A student prepared a $KMnO_4$ solution by dissolving 1.98 g in 250 cm^3 of water and standardized it using 0.02 M Mohr's salt solution in acidic medium. 25.0 cm^3 of Mohr's salt was used.

(a) Three titrations were done. The diagrams below show parts of the burette before and after each titration. Use these diagrams to complete the table of results.

Titration number	1	2	3
Final reading (cm^3)			
First reading (cm^3)			
Volume of solution A used			
Best titration result (✓)			



Tick (✓) the best titration results. Using these results, the average volume of A ---------- cm^3.

(b) Write the balanced equation for the titration. **[1]**

(c) Calculate the exact molarity of the $KMnO_4$ solution after standardization. **[2]**

(d) Determine the volume of this standardized $KMnO_4$ solution required to prepare 250 cm^3 of 0.01 M $KMnO_4$ by dilution. **[1]**

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Q No.3. 25.0 cm^3 of a sodium carbonate solution required 23.5 cm^3 of 0.1 M hydrochloric acid for complete neutralization. The solution was prepared by dissolving 6.0 g of impure Na_2CO_3 in 1 dm^3 of solution.

(a) Write the balanced chemical equation for the neutralization reaction. **[1]**

(b) Calculate the molarity of the Na_2CO_3 solution. **[2]**

(c) Determine the percentage purity of the Na_2CO_3 sample. **[2]**

(d) What indicator is suitable for this titration? State its colour change at the endpoint. **[1]**

SECTION B (4 × 3 = 12 Marks)

Note: Attempt all questions and write answers within the provided spaces.

Q No.4.

(a) A student added 2,4-dinitrophenylhydrazine (2,4-DNP) to an unknown organic compound containing two carbon atoms and observed formation of an orange precipitate. What type of functional group does the compound contain? **[1]**

(b) The same compound produced a silver mirror with Tollen's reagent. Write the name and structural formula of the compound. **[1]**

(c) Name the reagent used to distinguish an alkene from an alkane by colour change. Write the reaction. **[1]**

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Q No.5.

(a) Name one gas that can be collected by downward delivery and state the reason. **[1]**

(b) Draw a labeled diagram of an apparatus used to collect a gas by water displacement method. **[1]**

(c) Name the test reagent used to identify phenol by forming a violet colour. **[1]**

Q No.6.

A student was asked to determine the amount of barium ions (Ba^{2+}) present in a solution by precipitating it as barium sulfate using excess sulfuric acid.

(a) Write the balanced chemical equation for the reaction. **[1]**

(b) If 0.233 g of $BaSO_4$ was obtained from 25.0 cm^3 of solution, calculate the molarity of Ba^{2+} ions in the solution. **[2]**

(c) What is the basic principle of iodoform formation? **[1]**

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SOLUTION PRACTICE (PBA) MODEL PAPER-1 Marks 30

SECTION A

Q1(a)

(i) NO_3^- (nitrate ion). Gas evolved = NO_2

(ii) Brown ring test confirms presence of nitrate ion.

(iii) $FeSO_4 + 3\mathbf{NO_2} + H_2O \rightarrow 2HNO_3 + FeSO_4.\mathbf{NO}$ *(Brown ring)*

Q1(b)

(i) Cu^{2+}

(ii) $Cu(OH)_2$ (forms $[Cu(NH_3)_4(H_2O)_2]^{2+}$ in excess NH_3)

(iii) Copper(II) sulfate, $CuSO_4 \cdot 5H_2O$

Q2 (a)

Titration number	1	2	3
Final reading (cm^3)	20.5	29.9	25.1
First reading (cm^3)	0.5	10.0	5.0
Volume of solution $KMnO_4$ used	20.0	19.9	20.1
Best titration result (✓)	✓	✓	✓

The average volume of $KMnO_4$ = 20.0 cm^3.

(b) $2KMnO_4 + 10FeSO_4.(NH_4)_2SO_4.6H_2O + 8H_2SO_4 \rightarrow K_2SO_4 + 2MnSO_4 + 5Fe_2(SO_4)_3 + 10(NH_4)_2SO_4 + 68H_2O$

(c) **$KMnO_4$ Mohr's salt**

$$\frac{M_1 V_1}{n_1} = \frac{M_2 V_2}{n_2}$$

$$M_1 = \frac{M_2 V_2}{n_2} \times \frac{n_1}{V_1} = \frac{0.02 \times 25.0}{10} \times \frac{2}{20.0} = 0.05\ M$$

Given concentration = Required concentration

$$\mathbf{M_1V_1 = M_2V_2}$$

$$0.05 \times V_1 = 0.01 \times 250$$

$$V_1 = \frac{0.01 \times 250}{0.05} = 50\ cm^3$$

Measure 20 cm^3 of 0.05 M $KMnO_4$ solution using a measuring cylinder. Transfer it into a 250 cm^3 volumetric flask, then add distilled water up to the mark and mix thoroughly.

Q3

(a) $Na_2CO_3 + 2HCl \rightarrow 2NaCl + H_2O + CO_2$

(b)

Na_2CO_3 HCl

$$\frac{M_1 V_1}{n_1} = \frac{M_2 V_2}{n_2}$$

$$M_1 = \frac{M_2 V_2}{n_2} \times \frac{n_1}{V_1}$$

$$M_1 = \frac{0.1 \times 23.5}{2} \times \frac{1}{25.0} = 0.0470\ M$$

(c) Molar mass of Na_2CO_3 $= 23 \times 2 + 12 \times 1 + 16 \times 3 = 106\ g\ mol^{-1}$

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$$\text{Mass of } Na_2CO_3 \text{ per dm}^3 = \text{Molarity } (M_1) \times \text{Molar mass of } Na_2CO_3$$
$$= 0.0470 \times 106$$
$$= 4.98 \text{ g dm}^{-3}$$

$$\text{Percentage purity } Na_2CO_3 = \frac{\text{Mass of } Na_2CO_3 \text{ obtained from calculations in 'c'}}{\text{Initial mass of } Na_2CO_3 \text{ dissolved per dm}^3} \times 100$$

$$\text{Percentage purity of } Na_2CO_3 = \frac{4.98}{6.0} \times 100$$

Percentage purity of Na_2CO_3 = 83 %

(d) Methyl orange: yellow to orange red

SECTION B

Q4

(a) Aldehyde or ketone group (C=O).

(b) Ethanal (CH_3CHO). Since, compound contains two carbon atoms.

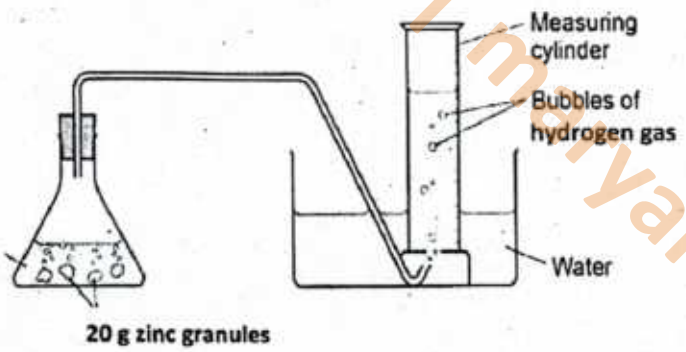
(c) Alkenes are oxidized to ethylene glycol by $KMnO_4$. The colour of $KMnO_4$ is discharged. This is called Baeyer's test. This test is not given by alkanes

$$3CH_2{=}CH_2 + 2KMnO_4 + 4H_2O \rightarrow \underset{\text{OH}}{\overset{|}{3CH_2}}{-}\underset{\text{OH}}{\overset{|}{CH_2}} + 2MnO_{2\,(s)} + 2KOH$$

Q5

(a) H_2 gas. It is collected by downward displacement of water.

(b)



(c) $FeCl_3$: Phenol reacts with $FeCl_3$ to give violet colour.

Q6

(a) $BaCl_2 + H_2SO_4 \rightarrow BaSO_4 + 2HCl$

(b) Molar mass of $BaSO_4$ = 233.3 g/mol

$$\text{So, number of moles} = \frac{0.233}{233} = 0.001 \text{ mol}$$

Volume = 25 cm^3 = 0.025 dm^3

$$\text{Thus, molarity} = \frac{0.001}{0.025} = 0.04 \text{ M}$$

(c) Aldehydes, methyl ketones and primary, secondary alcohols having α-methyl groups react with I_2 to form yellow crystals of iodoform in the presence of a base.

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PRACTICE (PBA) MODEL PAPER-2 Marks 30

Model Question Paper Chemistry HSSC (COMPOSITE) For Annual Examination 2026 & onwards Practical Based Assessment (PBA) Chemistry Curriculum (2022-23)-Scheme of Studies 2006

Total Marks: 30 **Time: 2 Hour 30 minutes**

Note: Attempt all questions and write answers within provided spaces on E-Sheet.

SECTION A (6 × 3 = 18)

Q No.1. Salt analysis

Two solids A and B were analysed. Solid A was colourless; solid B was blue. Each was dissolved in distilled water and tested as shown.

(a) Tests on A

Test	Observation
(i) Appearance of A	White crystalline solid
(ii) Filter ash test	Green ash is formed
(iii) To a portion of solution A add aqueous NaOH dropwise, then in excess	White precipitate forms, dissolves in excess NaOH giving a colourless solution
(iv) To another portion add concentrated $FeSO_4$ then carefully add concentrated H_2SO_4 down the side of the test tube	A brown ring appears at the junction of the two layers

Answer the following:

(i) Name the basic radical (cation) present in A. **[1]**

(ii) Name the acid radical (anion) present in A. **[1]**

(iii) Name the compound A and give its formula. **[1]**

(b) Tests on B

Test	Observation
Test 1: Appearance of B	Blue crystalline solid
Test 2: Flame test	Greenish-blue flame observed
Test 3: Add aqueous NaOH dropwise, then in excess	Light blue precipitate formed; insoluble in excess NaOH (remains)
Test 4: Add aqueous ammonia dropwise, then in excess	Light blue precipitate dissolves in excess ammonia to give deep azure-blue solution

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Answer the following:

(i) Name the cation present in B. **[1]**

(ii) Write the formula of the precipitate formed in test 3. **[1]**

(iii) Name the compound B. **[1]**

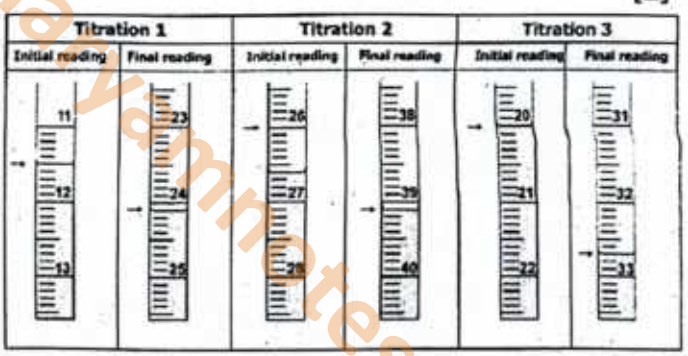
Q No.2. A student standardized 0.0200 M $KMnO_4$ (solution A) by titrating 20.0 cm^3 of Fe(II) salt ($FeSO_4.(NH_4)_2SO_4.6H_2O$) solution B against A. The molar mass of the iron salt = 392 g mol^{-1}. The student dissolved 14.0 g of the Fe(II) salt per dm^3 to prepare solution B. Balanced equation in acidic medium is:

$$2KMnO_4 + 10FeSO_4.(NH_4)_2SO_4.6H_2O + 8H_2SO_4 \rightarrow K_2SO_4 + 2MnSO_4 + 5Fe_2(SO_4)_3 + 10(NH_4)_2SO_4 + 68H_2O$$

(a) Name the indicator used and what colour change is observed at the end point? **[1]**

(b) Three titrations were done. The diagrams below show parts of the burette before and after each titration. Use these diagrams to complete the table of results. **[2]**

Titration number	1	2	3
Final reading (cm^3)			
First reading (cm^3)			
Volume of solution A used			
Best titration result (✓)			



Tick (✓) the best titration results.
Using these results, the average volume of A ------ cm^3.

(c) Calculate the molarity of Fe^{2+} in solution B. **[1]**

(d) Using (c) and the given mass (14.0 g dm^{-3}), calculate the percentage purity of the iron salt sample. **[2]**

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Q No.3. 10 cm^3 of 0.1 M NaOH was titrated against hydrochloric acid solution. This required 20 cm^3 of HCl solution to reach the end point.

The reaction is: $NaOH + HCl \rightarrow NaCl + H_2O$

(a) Name a suitable indicator and write the colour change at end point. **[2]**

(b) Calculate the molarity of the HCl solution. **[2]**

(c) Calculate the volume (in cm^3) of this acid required to prepare 500 cm^3 of 0.02 M HCl. **[2]**

SECTION B (4 × 3 = 12 Marks)

Attempt all questions.

Q No.4.

(a) Write the chemicals/reagents required for preparation of iodoform from a methyl ketone (or ethanol), and give the balanced chemical equation. **[1+1]**

(b) Give the observation for identification of phenol (use $FeCl_3$ solution) and the equation. **[1+1]**

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Q No.5.

(a) Explain how to distinguish an aldehyde from a ketone using Tollen's reagent; give the observation and the equation. **[1+1]**

(b) State two factors that affect the rate of a gas-evolving reaction. **[1+1]**

Q No.6.

A student adds a few drops of acidified $KMnO_4$ to three organic liquids: ethanol, ethene and cyclohexane.

(a) Which of these will decolourize the $KMnO_4$ and why? Give brief reason. **[1+1]**

(b) What is the colour of the $BaCrO_4$ precipitates formed during the gravimetric estimation of Ba^{2+} **[1]**

(b) What is the colour of the precipitates formed when an aldehyde reacts with Fehling's solution. **[1]**

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SOLUTION PRACTICE (PBA) MODEL PAPER-2 Marks 30

SECTION A

Q No.1.

(a) Tests on A

(i) Basic radical (cation): Zn^{2+} .

- The formation of green ash in filter ash test is an indication of Zn^{2+}
- On addition of NaOH white gelatinous precipitate ($Zn(OH)_2$) forms which dissolves in excess NaOH

$$\mathbf{ZnCl_2} + 2NaOH \rightarrow 2NaCl + \mathbf{Zn(OH)_2} \quad \textit{(White ppt.)}$$

$$\mathbf{Zn(OH)_2} + 2NaOH \rightarrow Na_2\mathbf{ZnO_2} + 2H_2O \quad \textit{(Clear solution, soluble)}$$

(ii) Acid radical (anion): NO_3^- (nitrate).
Reason: Brown ring test ($FeSO_4$ + conc. H_2SO_4) gives brown ring indicating nitrate.

(iii) Name & formula of A: Zinc nitrate, $Zn(NO_3)_2$.

(b) Tests on B

(i) Cation present: Cu^{2+} .

(ii) Formula of precipitate in test 3: $Cu(OH)_2$ (light blue solid).

$$\mathbf{CuSO_4} + 2NaOH \rightarrow Na_2SO_4 + \mathbf{Cu(OH)_2} \quad \textit{(Blue ppt.)}$$

(iii) Name of compound B: Copper(II) sulfate pentahydrate, $CuSO_4 \cdot 5H_2O$.

Q No.2.

(a) $KMnO_4$ itself acts as an indicator. The $KMnO_4$ is run from burette, so the very pale pink colour is the end point

(b)

Titration number	1	2	3
Final reading (cm^3)	24.1	39.1	32.7
First reading (cm^3)	11.5	26.6	20.0
Volume of solution $KMnO_4$ used	12.6	12.5	12.7
Best titration result (✓)	✓	✓	✓

The average volume of $KMnO_4 = \underline{12.5}\ cm^3$

(c) **Fe(II) salt** **$KMnO_4$**

$$\frac{M_1 V_1}{n_1} = \frac{M_2 V_2}{n_2}$$

$$M_1 = \frac{M_2 V_2}{n_2} \times \frac{n_1}{V_1}$$

$$M_1 = \frac{0.0200 \times 12.5}{2} \times \frac{10}{20.0} = 0.0625\ M$$

(d)

Molar mass of Fe(II) salt $= 392\ g\ mol^{-1}$

Mass of $FeSO_4.7H_2O$ per dm^3 = Molarity (M_1) × Molar mass of Fe(II) salt
$= 0.0625 \times 392 = 24.5\ g\ dm^{-3}$

Mass of Fe(II) salt dissolved in 250 cm^3 = 14.0 g

So, 250 cm^3 solution contains Fe(II) salt = 14.0 g

1 cm^3 solution contains Fe(II) salt $= \frac{14.0}{250}$ g

1000 cm^3 solution contains Fe(II) salt $= \frac{14.0}{250} \times 1000 = 56.0\ g\ dm^{-3}$

Hence, percentage purity of Fe(II) salt $= \frac{24.5}{56.0} \times 100 = 43.8\ \%$

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Q No.3.

(a) Indicator: Phenolphthalein because it is suitable for strong acid vs stronge base titration.
Colour change: Initially base is present in the titration flask so the colour is pink. At the end point base is consumed so the indicator changes colour to very light pink or just colouless.

(b)

$$\frac{M_1 V_1}{n_1} = \frac{M_2 V_2}{n_2}$$

$$M_1 = \frac{M_2 V_2}{n_2} \times \frac{n_1}{V_1} = \frac{0.1 \times 10}{1} \times \frac{1}{20} = 0.05\ M$$

(c) Given concentration in "b" = Required concentration

$$M_1V_1 = M_2V_2$$

$$0.05 \times V_1 = 0.02 \times 500$$

$$V_1 = \frac{0.02 \times 500}{0.05} = 200\ cm^3$$

Measure 200 cm^3 of 0.05 M HCl solution using a measuring cylinder. Transfer it into a 500 cm^3 volumetric flask, then add distilled water up to the mark and mix thoroughly.

SECTION B

Q No.4.

(a) Reagents for iodoform (from ethanol or methyl ketone): Iodine (I_2) and NaOH or Na_2CO_3/NaOH + I_2.
Observation: Pale yellow crystalline precipitate of iodoform (CHI_3) with characteristic antiseptic smell.
Equation: $CH_3CH_2OH + 4I_2 + 6NaOH \rightarrow CHI_3 + HCOONa + 5NaI + 5H_2O$

(b) Aqueous solution of phenol reacts with freshly prepared neutral ferric chloride solution gives coloured complex. Thus, phenol gives violet colouration

$$6C_6H_5OH + FeCl_3 \rightarrow [Fe(C_6H_5O)_6]^{3-} \text{ (violet colour complex)} + 3HCl + 3H^+$$

Q No.5.

(a) Tollen's reagent test: Aldehyde reduces tollen's reagent to metallic silver which forms silver mirror on the inner surface of the test tube; ketone gives no reaction.

$$AgNO_3 + 3NH_4OH \longrightarrow [Ag(NH_3)_2]OH + NH_4NO_3 + H_2O$$

$$R{-}\overset{\overset{O}{\|}}{C}{-}H + 2[Ag(NH_3)_2]OH \longrightarrow RCOONH_4 + 2Ag + 3NH_3 + H_2O$$

Aldehyde — Silver mirror

(b)

1. Concentration of reactants : higher concentration generally increases the rate.
2. Temperature : higher temperature increases kinetic energy and reaction rate.

Q No.6.

(a) **Ethanol:** will slowly oxidize (acidified $KMnO_4$ decolourizes). This indicates oxidation of primary alcohol.
Ethene *(alkene):* rapidly decolourizes $KMnO_4$ (addition reaction / dihydroxylation) producing brown MnO_2 or colorless products.
Cyclohexane *(saturated hydrocarbon)*: does not decolourize $KMnO_4$ under mild conditions.
Unsaturated bonds and easily oxidizable functional groups react with MnO_4^- ; saturated C–C single bonds resist oxidation under these conditions.

(b) $BaCrO_4$ is yellow in colour.

(c) Brick-red precipitate of Cu_2O (copper(I) oxide)

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